THE STANDARD CYCLOPEDIA OF MODERN AGRICULTURE AND RURAL ECONOMY

MEADOW GRASSES

MEADOW GRASSES

A. Smooth-stalked Meadow Grass (*Poa pratensis*).

1. Spikelet.

B. Rough-stalked Meadow Grass (*Poa trivialis*).

1. Spikelet.

C. Water Meadow Grass (*Glyceria aquatica*).

1. Spikelet.

D. Floating Sweet Grass (*Glyceria fluitans*).

1. Spikelet. 2. Single flower.

THE STANDARD CYCLOPEDIA OF MODERN AGRICULTURE AND RURAL ECONOMY

BY THE MOST DISTINGUISHED AUTHORITIES AND SPECIALISTS UNDER THE EDITORSHIP OF

PROFESSOR R. PATRICK WRIGHT

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VOLUME VIII

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The classic series of articles on insects by the late John Curtis have been embodied in the work, revised by Professor F. V. Theobald and Mr. Cecil Warburton, M.A., and bear the initials of J. C. and F. V. T. or C. W.

In like manner the great botanical articles of the late Professor John Lindley, which, like Curtis's articles above mentioned, were contributed to Morton's *Cyclopedia of Agriculture*, have, under Professor A. N. M'Alpine's revision, been embodied over the initials J. L. and A. N. M'A.

THE STANDARD CYCLOPEDIA OF MODERN AGRICULTURE

Land (Economic Aspect). — The primary requisites of production on which the wealth of a people depends are human labour and natural agents, for without the co-operation of these two no production is possible. The latter include both matter and external forces, and usually the term 'land' is used in a technical sense as synonymous with natural agents. Thus Prof. Marshall (Principles of Economics, Bk. IV, ch. i) says: 'By Land is meant the material and the forces which nature gives freely for man's aid, in land and water, in air and light and heat'. This broad usage may be justified by the fact that under the existing legal conditions it is only by owning or renting land that control can be obtained over these natural materials and forces, or by the fact that they constitute one economic group, being given in a fixed quantity by nature, while man has no control over their supply.

Importance for the Production of Wealth. —The different forms of land contribute to the material wellbeing of the people in a variety of ways. Some afford facilities for transfer of goods from place to place, a certain space is necessary for carrying on any industry as well as for habitation, and from land alone come the raw materials of manufacture and the means of subsistence. But though land plays a part in all commerce and industry, it is in agriculture that a relatively large area is necessary for productive purposes as compared with other branches of industrial activity. The enormous importance of land as an agent of production was recognized by the earliest writers on economics, and indeed a French school of the 18th century, known as the Physiocrats, expressed the belief that work on the land was productive in a special sense as contrasted with manufacturing and mercantile pursuits. It alone, they said, yielded a net produce over the expenses of production, while manufacture merely changed the shape of materials already produced, adding a value corresponding strictly to the useful materials consumed by the artisans during the period of labour. Similarly, commerce only changed the place of materials already produced, and did not increase the wealth of the country any more than did manufacture. Wealth could only be increased by enlarging the quantity of useful materials over and above those consumed by the labourers, and such a *produit net* resulted from work on the land alone. Adam Smith did not accept this view, but while admitting manufacture and commerce to be productive of wealth, he still clung to a distinction between them and agriculture. 'In agriculture Nature labours along with man, and though her labour costs no expense, its produce has its value as well as that of the most expensive workmen'; while 'no equal quantity of productive labour employed in manufactures can ever occasion so great reproduction. In them Nature does nothing; man does all' (Wealth of Nations, Bk. II, ch. v). The ground on which he based this assertion of the superior productiveness of work on the land appears to be that it yields a surplus in the shape of rent in addition to wages and profits: yet this fact is not due to the greater bounty of nature in work on the soil than in other industrial pursuits, but rather to the limitations and variations of that bounty. Now, when natural forces have been exploited on a large scale for manufacturing and mercantile purposes, it is futile to ask whether nature contributes more to production on the soil than to other forms of production. 'Nature labours along with man quite as obviously in electric or water power in a factory as in farming, and in both cases adds to the wealth of the people.

Variations in Natural Endowments.— The one important truth which underlies the position of Adam Smith is, that for the production of a given quantity of commodities different amounts of outlay and effort are required according to the variations in natural conditions; and this is a feature of the utmost consequence in considering the economic significance of land as a factor of production, as a form of wealth, or as a source of income. One piece of land is naturally very much better endowed than another for assisting man in the production of goods; the inherent properties of the soil vary; the climate, rainfall, geographical position or geological formation favour one area more than another. Many of these natural circumstances, like geographical position, extension, and mineral deposits, are beyond the control of man, but others may be greatly modified by human exertion and knowledge, so that the conscious adaptation of the natural environment is one of the most noteworthy characteristics of recent times. Rivers are rendered better for navigation, canals are cut, natural harbours are improved even the climate may be modified slightly by such

methods as planting trees. In the case of agricultural land, however, the power of changing natural conditions is seen most strongly, not merely in clearing and draining, but in completely altering the character of the soil. Land may be robbed of its fertility by bad cultivation, and some protectionists in new countries have defended their tenet in the belief that a nation should endeavour to prevent the 'earth-butchery' which, in their view, results from exporting raw materials and land produce. On the other hand, a waste or a fen may be changed into a fertile farm. The extent to which such changes would occur was not foreseen by the classical economists, and they therefore spoke as if land had a natural fertility which could be altered very little by man; but the application of science to agriculture has enormously increased man's power in this respect. Instead of following the custom of earlier times, leaving the ground fallow one year in three for nature itself to recuperate, the adoption of suitable rotations and the application of fertilizers increase the productiveness of the soil. Moreover, lands which would never have been very fertile under natural influences alone, may be rendered highly productive by chemical treatment. Lacking some single element they are relatively unproductive; given that element they yield high returns for the efforts of the cultivator. Thus, while in newer countries the chief characteristics which fit land for productive purposes are given by nature, in an old country continuous cultivation, improvements due to the labour and capital of generations, change the natural conditions greatly and tend to raise the value of poorer soils relatively to richer, though this may temporarily be counteracted by increased facilities for obtaining produce from regions newly put under tillage. In such a country as Britain it is difficult to distinguish man's share from nature's share in the fertility and value of the land, especially in the case of that used for the more intensive forms of agriculture; and it may be urged that some of the land owes as much to labour and capital and as little to what Ricardo calls 'the original and indestructible properties of the soil' as does a brick or a piece of common earthenware. Nevertheless, most of these important improvements in the character of land become so inextricably conjoined with the natural factors that for many economic purposes they rank on the same plane. Either they do not wear out for a very long time, or they must be renewed when they deteriorate as a condition of any cultivation at all; and thus the capital invested in them is fixed permanently or for very long periods; it cannot be withdrawn even though the price of agricultural produce falls greatly. The line of demarcation between capital and land becomes very hazy here, it being impossible to say without qualification that the former is the product of past human labour while the latter is not, unless we are thinking merely of land as nature gave it, and that is an abstraction seldom met with in Europe. Yet it remains important to distinguish between capital and land for some purposes, inasmuch as in its essential attributes of extension and position the latter is a gift of nature and incapable of increase in amount by human effort, however much its productive qualities may be improved; and while an individual owner or cultivator may consider it as but one productive instrument among others, the economist, viewing it from the standpoint of society, must look upon land as a thing by itself. Essentially it is not a produced good, it is limited in quantity, and is appropriated by individuals. The capital required for a manufacture will sooner or later respond to the demand for it as expressed in the high prices of the goods, but the supply of land is fixed and cannot in this manner respond to price in an old country.

Since areas of land differ in the facilities they present to the cultivator, it follows that the produce from such varied sources will be raised at different costs per unit, according to the degree of fertility of the land relative to the particular produce in question. Wheat, which we take as the expression for agricultural produce in general, may be raised in one favourable area at much less cost of labour and capital per bushel than in another less fertile zone. In some places it will barely pay the farmer for his trouble and outlay; in others it far more than repays him. Differences in situation in respect to the market are precisely similar in their economic effects to differences of fertility, and may even be the more potent determinants of the relative importance of different lands in the production of wealth. The control of the superior differential advantages for production is obviously a source of income. This feature is common to almost all uses of land in the wide sense. Those who control the richest sources of supply of freshwater fish, the most accessible deposits of coal and iron, the most suitable building sites, the best sources of water power, and the like, have differential advantages for production over others, and can sell their produce at the same price as those who have to spend far more effort for an equal output. This fundamental characteristic of land, in unequally aiding different producers, points to the fact that when the demand for the produce is so great as to require the supply from lands of differing fertility and situation, the price must be high enough to remunerate those who bring forward that portion of the necessary supply which is raised with greatest difficulty. The producers with differential advantages over this marginal producer will therefore obtain a surplus.

Limitations to Productiveness.—Another feature of land, at least as important for economic purposes as limitation of quantity and variations of fertility or situation, is the response which land makes to intensive cultivation. It is obvious that there is a limit to the amount of produce which can profitably be raised from any land, for otherwise there would be no need for cultivating any but the very best. If an increase in the capital and labour applied to a plot of land yielded always a proportionate increase in the amount of produce, there would be no limit to the intensity of the cultivation which could be profitably carried on;

but it is characteristic of land that after a certain point in cultivation an increase in the capital and labour devoted to any particular plot results in a less than proportionate increase in the amount of produce raised. This Law of Diminishing Returns was emphasized by economists during the corn-law discussions of 1814–15, when it was affirmed that an actual diminution of returns was taking place because of the necessity for cultivating poorer lands and for cultivating more intensively. But though in the circumstances of the present it need not be affirmed that an actual diminution of returns is taking place, it is clearly a fact that, in the absence of any improvements in the arts of agriculture, there is a limit beyond which an increase in the labour and capital expended on a plot of land fails to yield a proportionate increase of produce. Improvements in the arts of agriculture will for a time suspend the action of the law, and increased knowledge of agricultural chemistry or geology will render it possible to incorporate in the soil quantities of labour and capital which yield a proportional return to a higher point than before. It is also true that some land may be so far undercultivated that an increase in the capital and labour spent upon it will bring a more than proportionate increase in the produce. But when allowance has been made for these modifications, it remains true that in each stage of progress after a certain point has been reached in intensive cultivation the return to extra effort and outlay increases at a slower and slower rate. Whether it will pay or not to cultivate for a diminishing return to some point, depends upon the price of the produce; but there is an obvious limit even to this at any particular time, as is shown by the fact that farmers limit the intensiveness of their cultivation and use their resources rather in extending the ground they farm than in further concentration upon a narrower area. Thus, besides an extensive margin of cultivation, there is also an intensive margin. The land that in the circumstances of the time will just repay the expenses of cultivation with normal remuneration for the farmer is on the extensive margin; while the return to the last increment of capital and labour which can profitably be applied to any particular land, however fertile or favourably situated, is the marginal return which indicates the intensive margin of cultivation. The extra return beyond this to previous increments or 'doses' will constitute a surplus which enters into the determination of economic rent. (See Rent.) The position of the margin depends upon whether the land is rich or poor, on differences in the demand for produce, on the quantity of land in proportion to population, on the situation of the land, as well as on the development of agricultural sciences and arts.

Relation of Land to Population. — The possibility of diminishing returns to increased expenditure upon land was used by the earlier economists to show that as population increased, the food supply could not go on increasing without greater and greater expenditure per unit of produce. They may have given too little weight to the possible improvements in the arts of agriculture, economies of organization, and especially facilities of transport from abroad; but it remains true that if population increases while no change occurs in these respects, greater difficulty must be experienced in providing the necessaries of life, and therefore it is quite possible for there to be too many people in comparison with the area of land available. If it were not for the increased facilities of importing food since the time of Malthus, there can be little doubt that Britain would be overpopulated in this sense; but, as it is, we obviate the danger of diminishing returns by exchanging our manufactures for foreign supplies of agricultural produce. How long we can count upon the continuance of this is doubtful, for the new countries are increasing rapidly in population and will require more and more of their own agricultural produce. Hence in the future, if the pressure of population on the available agricultural land is to be avoided it must be by improvements in the methods of production which will increase the effectiveness of our resources. For this we must look to increased intelligence and skill.

Land as Wealth.— It is usual, in comparing the wealth of different countries, to include the value of land in the estimates, but this is of doubtful propriety. Land is a form of wealth which stands by itself, because an increase in its value may not be due to any increase either in the capital incorporated with the soil or in the national resources, but merely to its increasing scarcity relative to the population. The individuals who own the land will rightly count such value as part of their wealth; but as the aggregate area remains the same, and the higher value put upon it is an expression of the greater pressure of the population, it can scarcely be considered without qualification as an increase in the real resources of the people. It is rather a sign of increased needs. This is seen especially in the case of urban sites, where pressure of population may result in high values without any effort or outlay on the part of owners; but that it applies to land in general may be exemplified by the fact that in 1880 the value of the vast area of the United States was about equal to that of the United Kingdom, while as the population rapidly increases in the former the aggregate value of the land rises very much faster than that of the latter. The same point might be illustrated by the consideration that the value of the land of England nearly doubled from 1795 to 1815, and it is a curious fact that a series of bad harvests in a country which cannot import food has been known to send up the value of land greatly. But improvements in transport, free trade, and the opening up of new countries have led to a fall in the value of agricultural land in the United Kingdom since 1873. An increase in the value of rural land is not, therefore, in itself an indication of growing wealth: it may even be coincident with a diminution of the real means of the people. Similarly, a fall in its value may coincide with an increase in their real means, as has been recently the case in Britain. This has fre-

quently been brought forward as disproving the assertion of Malthus and Ricardo, that as a people prospers it redounds to the advantage of the owners of land; but if we include urban as well as rural land, their contention remains true even of Britain, for the aggregate value of the former is now greater than that of the latter. The annual value in terms of money of all the land of Britain is about twice as high as it was at the time of the repeal of the corn laws, while in the meantime the purchasing power of money has increased enormously, making the *real* value perhaps four times as high as it was sixty years ago.

The productiveness of land is dependent upon a good system of tenure, since the inducement to outlay and energy on the part of the farmer will be affected by the degree of certainty of his reaping all the rewards of his effort; and the reactions of an inappropriate or oppressive system in deteriorating the character, lowering the enterprise, and limiting the aspirations of the people can scarcely be exaggerated. Thus it was that mediæval forms of landholding, such as the strip system in the English manor and the analogous 'runrig' cultivation in Scotland, practically suppressed initiative and hopefulness, hardened customs and traditions into rigid rules affecting even the most trivial details of farming, so that one economic authority believes it probable that the divided ownership and consequent network of regulations regarding cultivation were the most important of all the causes which delayed for so long the growth of the spirit of free enterprise in Britain. There is no doubt that in Scotland defective systems of tenure were the chief cause of the continuance of bad farming down to the early part of the 18th century; the farmers were universally admitted to be ignorant and prejudiced against new methods, but the radical cause of their defects was the primitive conditions of land tenure. Leases were almost entirely absent, and in many parts of the country the runrig system still remained. Each large field was divided by ridges into a large number of strips, generally crooked and from 20 to 40 ft. wide, and a farmer seldom held contiguous strips, but many scattered about all over the township. These strips were usually reallotted annually, and thus no holder had the slightest inducement to improve the land, which would probably pass out of his hands in a year's time; and after harvest the whole area was open and common pasturage for all. Such a system of tenure fostered indifference and poor cultivation, repressed initiative and changes. It was only when it gradually died out and leases also became common that cultivation in Scotland perceptibly improved, and the farmers showed themselves to be energetic and persevering, so that the efficiency of the Scotch farmer, whether at home or in new countries, is now a matter of general recognition.

So much impressed have some writers been by the necessity for security of tenure as the essential condition of efficient cultivation, that they have advocated the ownership of the land by the individual cultivators as the method best calculated to lead to the highest productivity of the soil; and a number of nations have in the past, partly for this and partly for other social reasons, facilitated occupying ownership. In Ireland it is now being largely adopted, and many have urged its claims in connection with the development of small holdings in Great Britain. The system of occupying ownership certainly presents many features which it is not easy to attain under any other method of tenure. French economists have almost always been strongly favourable to it, and though in Britain until the early part of the 19th century it was looked upon with distrust, the writings of Kay, Laing, Thornton, and J. S. Mill did much to initiate a reaction to a more favourable opinion. There is perfect security of capital invested; improvements due to the exertion of the holder return their reward to him or his family, and therefore they are the more readily effected; there is absolute freedom to crop in the most profitable way; and where there are two parties, owner and tenant, interested in a farm, there is always the possibility of their interests conflicting in a manner which is impossible when both present and future interests are in the care of the same individual. The permanent qualities of the soil will not be sacrificed to a small temporary gain, and this will be prevented without the troublesome interference of an owner or rigidly harassing restrictions. Consequently it is urged that wherever the system of occupying ownership exists there will be industry, thrift, security, confidence in the future, and independence. The farmer will employ every moment not required by the labours of the year in something beneficial to himself or his children in the future; his patrimony will be a true savings bank, always ready to receive all his gains and utilize all his moments of leisure, while the status of ownership adds a relish to drudgery. Arthur Young, though an upholder of the English system of large estates, granted that 'the magic of property turns sand into gold'; and while the success of modern Danish agriculture is influenced greatly by their systems of agricultural education and co-operation, the adoption of peasant proprietorship has also undoubtedly contributed greatly towards it. The pride of ownership, and the social status which it confers, reflect themselves in the good house accommodation in the countries where the farmers are alert and intelligent.

On the other hand, a number of objections are raised against the system. It almost of necessity involves in an old country a system of small farming, and indeed this has been carried to excess in some places by uneconomic subdivision or *morcellement*, partly due to laws like those in France, and partly to the real difficulties which arise on questions of inheritance. When the farms are too small they are often cultivated intensively so long as they yield any appreciable return to the extra labour, as they cannot afford a livelihood without a disproportionate amount of effort expended upon them. It is said that in some countries the system breeds parsimoniousness, which differs

from truly economic thrift by deteriorating character, lowering the consumption of food, and leading to inefficiency; for it is demonstrable that a system which tends to industry, even to working all the waking hours, may not lead to a corresponding productivity. It used to be urged, too, that the small proprietors become very conservative in methods, and that even were they willing to adopt improved machinery and methods they were often precluded from so doing by the limited capital at their disposal; but this charge is by no means so true now as formerly, since the adoption of co-operative methods has overcome some of the difficulties of small farming and marketing, while a good educational system entirely removes the sentiment against improvement. There are some social results of an undesirable nature attributed to the system in France, such as the temptation to marry for the sake of property, and the restriction to the spirit of enterprise and mobility which is involved in the inducement to wait about for the small inheritance. The danger of mortgaging is also brought forward, though it may be answered that a light mortgage on a farm still leaves the sole control to the proprietor. Further, if it must be assumed that occupying ownership in the old world almost necessarily involves small farming, it may be urged that the system would be unsuitable where the climatic, geographical, and economic conditions call for large farming. Yet the changes in the world market for produce during the last thirty years have been relatively favourable to small farming in Europe, as it is the commodities suited to large farming which have come in increasing volume from the virgin soils of the new world; and for various social and economic reasons the ideal system in Britain, if not in all countries, would be one in which there was not a single uniform pattern of holding, but a graduated series of all sizes and values, so that there would be room for variety of methods and for advance step by step for the enterprising farmer. Such opportunities for rising are of great economic value by increasing hopefulness. The base of the pyramid should be a widely diffused system of small farms, and the apex as large a farm as the most efficient individual can economically control, and that must vary with the locality and the nature of the produce. Hence in Britain attention has been latterly confined to the advisability of encouraging ownership among the small farmers, where detailed work and the 'eye of the master' count for most in the success; and the analogy of Continental countries and Ireland has lent some support to the movement. But the small experience of the system in England and Scotland has not been uniformly satisfactory hitherto, for the owners fall rapidly before the changes in the market for produce and in prices, and on the small copyholds in Downham (Cambridgeshire) the conditions of life are said to be by no means desirable. It is also objected, that the adoption of the system here would involve a very great demand on the public credit, and that the farmers of Great Britain are less desirous of ownership than those of Ireland and Continental countries; though there is some inconsistency in urging both these objections together, since there is no proposal to force men to buy, and if they are so averse to it as is suggested the demands on the public credit would be small. Further, it is said that the farmer's capital would be all tied up in his land, so that he would have insufficient for stocking and working the farm properly, though this would be mitigated by gradual purchase on an instalment system; and, finally, that practically equal security can be obtained under the tenancy system by adaptations such as the Small Holdings Act, 1907, has brought about in England, though it remains to be seen whether the County Councils will prove to be efficient landlords under this new scheme. That Act showed a distinct bias against facilitating the purchase of small holdings; but while we believe that in general the temper of our people and the nature of our economic conditions are not very favourable to occupying ownership, there are good grounds for urging that not a few people would find their happiness under the system, and there should be no hindrances to their acquisition, as, for instance, in the nature of high legal charges on transfer of small properties, even if more positive facilities of purchase are not given by the State. The fact that the option of acquiring properties under the Small Holdings Act, 1892, was taken advantage of only in a very few cases is not in itself proof of the lack of desire, for that Act was equally unsuccessful in creating many small holdings on a rental system, and yet nobody affirmed that there was no demand for holdings. It is not contended that in Britain there should be a uniform system of peasant properties irrespective of the locality and produce, for each system of tenure has its advantages, varying according to conditions; but it is economically good that there should be variety of opportunities, and that none should be debarred by artificial hindrances from acquiring small properties if they desire to do so.

In newly settled countries this method of holding land is generally adopted; but there land is very cheap, and the crops are raised with a relatively low outlay of capital on a plan of extensive farming which is unsuited to old countries with a large population in proportion to area. There is some tendency, even in America, in localities where the population is so large as to render more intensive cultivation profitable, to separate the landowner and tenant on the English pattern.

A system of tenure which also presents advantages of its own is Metayage, for it affords scope for energetic men who are possessed of little capital. Originally and strictly the term applied only to the method by which the landowner received as his share one-half of the produce of the farm, but it is now applied to all similar arrangements irrespective of the proportion of the yield which accrues to the owner. It involves more of an industrial partnership than the English system, and is common in Italy, Portugal, Russia, and in some parts of France, though it appears to have been more general than it now is. Adam Smith says that

in his day five-sixths of the whole kingdom of France was occupied by this species of cultivators. The holding is generally much larger than the peasant property, and the proportion of the capital advanced by the owners as well as the proportion of the produce which they obtain in return vary now from place to place. Generally speaking, the metayer provides the labour and the implements—though hired labourers are not frequently found under the system,—while the owner provides the land, buildings and immovables, and the cattle; but sometimes the owner provides the implements also, while in other cases both parties share equally in the provision of stock. These divisions of outlay and of produce depend upon local customs, and so are varied; but in essence it is more of a partnership than the relation of owner and tenant in Britain, for anything reducing the produce of the farm as a unit reduces the share of the owner as well as of the occupier. It seems, in years gone by, almost invariably to have spelt bad farming, and nearly all the older writers condemn it. Arthur Young summarily dismisses it with the remark that there is not one word to be said in favour of the practice and a thousand arguments that might be used against it, and his dislike was shared by Mirabeau, Turgot, and Adam Smith. The objections were raised especially to that form of the system in which the tenant provided only the labour and a few implements of little value, but none of the stock, cultivating 'only by means of what the landlord advanced to him' (Wealth of Nations, III, ii). To this there is the obvious and strong economic objection that it discourages any approach to intensive cultivation, since the tenant will not expend a further increment of labour unless it yields a sufficiently high return for his effort and allows as much again for the owner. Similarly, the owner would be equally unwilling to increase the stock unless the return sufficed to repay him and at the same time allowed one-half to the metayer. A tithe, in the ancient sense of a tenth of produce, was a very serious hindrance to improvements and exertion, because the more a farmer worked, and the more capital he sunk in the land, the more he had to pay to the tithe owner, and a division of half and half must have a still greater effect in this direction, inevitably discouraging intensive cultivation.

The metayage system, however, has recently become more flexible, the amount of capital supplied by each party and the proportion of the produce accruing to each being sometimes fixed by contract, while in some localities the custom demands an equal capital from both. In such cases the objection has not the same force, though it may not altogether disappear. The tenant will not have the same difficulty in obtaining a further subscription of stock from the owner when he himself must provide half. Being a poorer man than the owner, he would suffer more severely from any loss, and so will not be over-hasty; but as the whole of the labour still comes from the tenant alone, there would seem to remain a lower inducement to intensive cultivation than under other methods of tenure, although the local usages and contracts may modify even this by requiring a certain standard of farming. Nevertheless the owner must have power to interfere in the management of the farm, to see that the tenant does his work adequately, as well as to guard against the employment of the cattle for outside work for which the profits would go wholly to the tenant; and such detailed interference would be inconsistent with the spirit of the British farmers. On the other hand, the beneficial features of the system are that the metayer can cultivate with a smaller capital of his own than the British farmer; that the payment in kind of the owner's share makes the tenant more independent of the variations of prices of produce than if he had to pay in money a fixed rent; that a bad harvest is not a burden solely upon him, but automatically affects the amount of produce accruing to the owner; while the interference of the owner may in many cases be very beneficial if he is capable of giving advice and knows how to treat the metayer judiciously, for there is a more obvious unity of interest between the parties than under most other systems of tenure. There is also considerable fixity of tenure under the system; for since the owner's share is a fixed proportion of the produce, he has no interest in ousting an efficient tenant, but rather in inducing him to remain, because the greater the efficiency of the farming the larger will be the amount of the produce obtained by the owner. Thus, although Adam Smith viewed metayage as a stage in the progress from villainage to rent-paying farmers, necessitated by the poverty of the enfranchised serf, and destined to disappear in the evolution of agriculture, if the system is rendered increasingly flexible it may be prevented from dying out by the real advantages which it possesses; and in parts of Europe the metayer is to-day a fairly enterprising agriculturist, adopting new methods quickly, and often encouraged to do so by the interested advice and assistance of the landlord. It has been adapted to sugar cultivation in some of the West Indian colonies under French influence, and a somewhat similar system of holding land on 'shares' of produce is frequently found where tenancies exist in Canada and in the United States, particularly in districts where there is a very poor white or negro population. But in America the contract varies according to the circumstances of each particular case, the share of the tenant being higher where the part played by labour in the production of the crop is relatively great, than where the part played by the fertility of the land and the outlay of owner's capital is relatively great. It is thought that metayage was not wholly unknown after the break-up of villainage in Britain, but the land and stock leases and steel-bow systems, under which the landlord frequently owned all or much of the stock, seem generally to have been based on a fixed money rental, the occupier returning stock of equivalent value at the end of the lease.

As contrasted with metayage the English system has the advantage of allowing greater freedom to the tenant, as the capital provided by the owner is generally in the nature of the

more permanent improvements, which do not require constant and detailed supervision or interference with the farmer's work. It is true that the system is open to various abuses, and may be used somewhat harshly in individual cases; but customs, traditional claims, and legislation have tended to soften the possible hardships, and to reduce to a minimum the loopholes for arbitrary treatment of the tenant. Thus, while in one aspect the payment of a money rent compares unfavourably with the payment in kind by the metayer, and during a period of falling prices of produce may be particularly burdensome for a time to the farmer, yet it is often softened down by remissions of a part of the rent in bad seasons, and there is a good deal of 'give and take' between the parties, expressing a sort of partnership, as where, because of bad times, the owner bears part of the expenses of repairs, &c., which in better times would have been left to the tenant. And this is only one aspect of the problem, for we have to contrast not merely a payment in money with a payment in kind, but a fixed money payment with a payment of one-half or other proportion of the produce; and while it has been seen that the latter must in some measure discourage high cultivation, it is to be observed that the former does not. It is a particularly good feature of the English system that the payment of a fixed annual sum for the use of land and buildings leaves every reasonable inducement to proper cultivation, for any line of expenditure will be undertaken by the farmer if it promises to repay him for his outlay and effort, and he has no more to pay to the owner in consequence, as would be the case under metayage. Again, though leases are not so common in England as in Scotland, and there is a danger of arbitrary action by owners which may render security of tenure insufficient from the point of view of economical cultivation, since it is a fact that some kinds of tenants' improvements are not exhausted for years, yet in practice good tenants have not generally been disturbed. Custom has frequently afforded some protection against loss due to improvements by a tenant who is evicted, and recent legislation has afforded still greater security in such directions. The latest Agricultural Holdings Act, which came into force on January 1, 1909, has also provided for compensation from the landlord for damage to crops caused by game, has greatly increased the freedom of cropping, and, under safeguards which render it of doubtful importance, has provided for compensation for unreasonable disturbance. The prevailing system of landlord and tenant works fairly well in our country, where the farmer must be possessed of some capital and special training for the work, and where there are many other industries besides agriculture which will attract from the land if owners as a class seriously abuse their position. If these circumstances are absent it is by no means so satisfactory; for where agriculture is the only industry, and the population poor and numerous relatively to the area, it leads to excessive competition for the available land, and rouses great animosity between the owners and tenants, especially if the former are also absentees. Hence it is generally admitted that a serious mistake was made early in the 19th century in trying to assimilate the Irish system of tenure to the English, for the conditions were not those in which it could prove successful. In parts of Scotland, for similar reasons, judicial rents have been introduced to modify competitive ones. Tenancies at will or from year to year would certainly not be conducive to good farming if there were no further security of tenure in the customs or the laws; but the English system as actually operative in Britain has the advantage, from the owner's point of view, of giving him some freedom in selecting acceptable tenants, though it is said with some truth that it has hindered the provision of an adequate supply of small holdings in some localities, and has thus afforded insufficient opportunities for energetic labourers and men of small means to engage in agriculture. Landowners have not been ready to face the increased cost of equipment required for a system of small farms, even where the rents would have been amply sufficient to remunerate them for the outlay; while it is to be feared that some have not wished to undertake the trouble of a numerous small tenantry, or have objected to it because it would interfere with sport. On the other hand, it is a feature of the English system that owners obtain a low net return on the capital which they sink in buildings and improvements, for seldom do they get more than 3 per cent for such outlay, while frequently it is less; and this is a lower rate than can be obtained in ordinary commercial investments, and to the farmers cheaper than they could borrow for the purpose if they were occupying owners. Where farming on a large scale is suited to the economic conditions this allows the tenant to work a larger area than would be possible under occupying ownership with his own capital; and though a metayer borrows a still larger part of the capital from the owner, he generally pays more for it in produce and is subject to more detailed supervision and control. See also CROFTER LEGISLATION, CAPITAL, PEASANT PROPRIETARY, TENANT RIGHT, and succeeding articles. [S. H. T.]

Land, Agricultural Value of.—This expression refers to the letting or farming value of land, in contradistinction to its urban or site value for building purposes. It is also understood to mean ordinary value, unaffected by its being cut up into small areas for gardens, allotments, or accommodation. The agricultural value of land is usually less than for any of these purposes, for reasons which are now stated *seriatim*.

1. Agricultural land is let in areas of considerable extent, at a rent which includes both the good and inferior portions, as well as waste land, roads, water, copses, woods, and the portions occupied by houses, buildings, orchards, or gardens. A sum is agreed upon for the whole, which works out at so much per acre. It is fixed by precedents, and in some degree by competition; but more often by custom or usage, the amount asked for as rent on many estates not having been altered for many years.

2. The rent is collected quarterly or half yearly from one responsible tenant, instead of from a number of tenants, as must be the case with small holdings.

3. The produce consists, as a rule, of ordinary crops and live stock, of limited pecuniary value, varying with the fertility of the soil. It probably amounts to little more than from £4 to £8 per acre, out of which many charges must be paid. The fact that a good crop of wheat of 40 bus. per acre is only worth about £9, and that this sum represents a maximum figure upon the portion under wheat, supports this conclusion. The remaining corn crops may, or may not, reach the same value, but the fallow and root land seldom yield much surplus beyond the costs of cultivation. A large proportion of the agricultural land of the country yields less than £5 per acre gross, and out of this small return per acre are to be defrayed labour, horse maintenance, seed, purchased foods and manures, rates, taxes, trade bills, and farmer's profits. The rent cannot be much under such circumstances, and hence the agricultural value of land either to the owner or the occupier is necessarily comparatively small.

4. The value of such land, if regarded from the owner's or purchaser's point of view, is affected by the following considerations: (*a*) All repairs are defrayed by the landlord, unless there exists an agreement to the contrary. (*b*) The landlord is liable for tithe, and is naturally expected to assist in maintaining churches, burial grounds, charities, &c., all of which detract from the value of the land viewed merely as an investment.

5. The capital value of the land is principally controlled by the net rent, or actual amount received after all outgoings have been deducted.

6. The rent itself is really fixed by the tenant and his competitors, for no landlord can enforce more than the highest tender: and in most cases, in England, rack rents are not demanded, but a reasonable sum, on the 'live-and-let-live' principle.

7. The value of agricultural land cannot therefore be great, although it varies between somewhat wide limits. If estimates are made of each annual expenditure, they will be found to mount up to such a figure as to cause some wonder as to where the rent is to come from. Labour can scarcely be kept under 25*s*. per acre; horse labour at less than £1; seed 10*s*.; manures and feedingstuffs 15*s*.; rates and taxes 5*s*.; trade bills and repairs of implements, say 5*s*.: =£4 per acre. If some of these expenses are capable of reduction, there are others which have not been mentioned; and the conclusion is irresistible that there is only, in the case before us, about £1 left to divide between the landlord and the tenant. All depends upon the gross value of the produce, for if the unavoidable expenses amount to £4 per acre, it is possible that 5*s*. or 10*s*. per acre is all the rent that can be squeezed out of the land. If the gross produce amounts to £6 per acre, and supposing this to be due to the fertility of the soil and not to greater expenditure, the rent may amount to £1 per acre. In the case of very fertile soils the rent may rise higher, but even in East Lothian and other favoured localities it is seldom more than £3 or £4 per acre.

8. As to the upward and downward limits of rent in the case of agricultural land, it is clear that if there is no margin between the value of the produce and the expenses of cultivation, including the farmer's maintenance as one of them, no rent, or a mere nominal rent only, can be paid. It is for this reason that wide areas of agricultural land only command 2*s*. 6*d*. to 5*s*. per acre. On the other hand, good land may, to put the matter briefly, command as many pounds per acre as other land can command shillings.

9. The capital value of agricultural land is arrived at by the same process as that applied to valuing any other security. It is done by finding the net annual value, which is by no means an easy task, and calculating the capital value on the basis of 25 or 30 years' purchase. For example, if the net value is 10*s*. per acre, the capital value will be £12, 10*s*. or £15 per acre. On a basis of 25 years' purchase the money invested should yield 4 per cent, and on a 30 years' purchase 3·3 per cent per annum.

10. The amenities of landed property confer an additional value on agricultural land. These are the sporting rights, whether reserved by the landlord or held by the tenant or gametenant. These rights are of very considerable value in the estimation of many men, and are, in any case, capable of realization by letting them. There is also the dignity attaching to the possession of large tracts of land, which is very attractive to many persons. In some cases the influence of these amenities is such, that land has been purchased at or over 50 years' purchase, or to yield 2 per cent or even less per annum. [J. WR.]

Land, Compulsory taking of. See art. COMPULSORY TAKING OF LAND.

Land, Methods of Improvement.—All land is capable of improvement unless it is inherently 'bad'. By bad is not meant poor, or of low productive power, but land impregnated with alkalis or other matter inimical to vegetation, or too shallow for cultivation. The salt plains of Hungary are incapable of improvement; but in our country such cases are rare, and, speaking generally, all land may be rendered fertile. The limits of land improvement are, however, controlled by profit—a fact liable to be overlooked by those who urge indiscriminate land improvement as a practical panacea for unemployment.

There are two principal means of improving land: (1) enrichment of the soil by manuring; (2) mechanical or textural improvement of the staple. Of these two methods the first is the simpler, and appeals directly to the occupier; while the latter involves a greater immediate outlay, and is generally undertaken by the owner.

Reference to the article ENGLAND, AGRICULTURE OF, will show that the land of the country has all been much improved since the 15th century, owing to cultivation and manuring, which two words really sum up the entire subject.

Land is susceptible of improvement in different degrees, on account of its varying capacity for retaining fertilizing matter and moisture. In the case of light soil resting upon gravel, improvement is liable to be shortlived, whereas stiffer and deeper soils, resting on a subsoil of similar character, are capable of permanent improvement. There is a marked difference between grass and arable land in this respect, for while the above remark is true of arable, it is not so as regards grass land. Down lands are capable of being converted into excellent pasture if retained in their original condition of natural herbage, liberally treated with fertilizer, and folded with sheep receiving artificial food. This seems indeed the best method of improving such naturally poor but wholesome pastures, and is to be preferred to breaking them up. The same principle might be applied to many large areas of poor grass land, of both light and heavy character, with equal success.

The enrichment of land may be accomplished through live stock and the consumption of imported foods in large quantities. This is only another form of yard-manuring and sheep-folding, both of which are time-honoured methods of improving land. The application of artificial fertilizers is more modern, and scarcely so certain or durable. Dressings of a more bulky and natural character are also largely used for improving land, such as lime, chalk, marl, composts, and ashes, each of which is treated of in its proper place (see LIMING, CHALKING, &c.). The uses of phosphatic, potassic, calcic, and nitrogenous substances owe their efficacy to the value of these materials as plant food. They increase the yield of crops, and, simultaneously, store up organic matter in the form of crop residues, improve the texture of the soil, and increase its depth. Good cultivation gradually improves soils, and a large head of live stock still further increases their fertility—the two going hand in hand, under the general description of good farming.

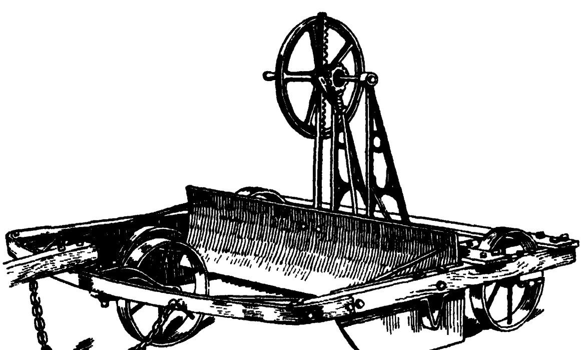
The second means of land improvement above alluded to, aims at a more rapid alteration of the mechanical character of the soil; and, among them, drainage occupies a premier position. Clay soils are almost all capable of improvement by drainage (see DRAINAGE), because it removes superfluous water, and greatly increases the percolative properties of the soil towards rainwater, and renders it beneficial instead of injurious. For other means of land improvement. readers are referred to the special articles upon SUBSOILING; TRENCH PLOUGHING; CLAY BURNING; CLAYING; CHALKING; MARLING; WARPING; &c. Some of these operations are critical in their nature, and require to be judiciously undertaken and performed, or entirely omitted. It is, for example, waste of labour to subsoil the stiffest classes of clay soils, and positively injurious to trench-plough shallow soils. Each operation should be carried out where it will prove beneficial, for they all entail considerable expense. Drainage is unnecessary where nature has already provided a system by which free percolation is secured, and it has sometimes proved injurious on certain classes of grass land.

The improvement of land absorbs large sums of money, and ought not to be lightly undertaken on a grand scale. The best course, apart from distinct faults, which call for immediate removal, such as wetness, or muirland pan, is to persevere in a system of gradual improvement, through good cultivation, liberal manuring, and the agency of live stock. The depth of the soil is better increased gradually, through successive rotations, and richness should be accumulative rather than suddenly produced. Some descriptions of arable land are incapable of permanent improvement, although they may be maintained in a state of high fertility year by year. Such are the light soils of the Upper Chalk, and of the Oolitic limestones. They are as quick to respond as they are liable to relapse, and two years of neglect, or suspension of effort, reduces them to their natural poverty. Grass land is less capricious, on account of its being less exposed to the washing away of fertilizing matter. The constant presence of a green covering prevents the downward passage of these ingredients, and preserves them near the surface. Cattle-grazing tends to keep the surface manured, and if the animals are liberally fed and sufficiently numerous, pastures cannot but improve. What cattle-grazing does for grass, sheep-folding does for light arable land; but the effect is more transitory, and requires to be more constantly repeated. Farmyard manure must be regarded as one of the most potent agencies for improving land. It is pre-eminently a *lasting* manure, and exerts as great an effect mechanically as manurially. It seems to unite, in one, the two principal factors of improvement, that is, fertilizing ingredients coupled with mitigating effects upon texture. It confers powers of retention, of moisture, and of manurial substances on light soils, and lightens the texture of clay soils. It is 'organic' in nature, and therefore increases the stock of humus in the soil, and this at once promotes porosity and the power of retaining moisture. The importance of this latter point can scarcely be overrated. [J. WI.]

Land, Property in.—Theoretically, according to the principles of English law, the idea of absolute ownership of land is unknown. No man is in law the absolute owner of land. He can only hold an estate in it. It is a fundamental rule that all lands within the realm were originally derived from the Crown (either by express grant or tacit intendment of law), and therefore the King is sovereign lord either mediate or immediate of every parcel of land within the realm. The principal freehold estates known to the law are estates for life, in tail and in fee simple. An estate for life is the smallest estate of freehold tenure, and lasts during the life of the grantee and no longer. An estate tail is an estate limited to a man and the heirs of his body. It may be either *general*, that is, limited to the heirs of his body generally and without restriction, in which case it will be descendible to every one of his lawful posterity in due course; or *special*, when it is restricted to certain heirs of his body, as to the heirs of his body by a particular wife. Estates tail may be also in *tail male*, which can only descend to male

issue, or in *tail female*, which can only descend to female issue. Such estates tail were formerly inalienable, but can now be disposed of under the Fines and Recoveries Act, 1833 (3 & 4 Will. IV, c. 74). (See art. ENTAIL.) An estate in fee simple is the greatest estate or interest which the law of England allows any person to possess in landed property. A tenant in fee simple holds land to him 'and his heirs' so that it descends on intestacy not merely to heirs of the body but to collateral relations, according to the rules of descent as set out in the Inheritance Act, 1833 (3 & 4 Will. IV, c. 106). Such an estate, though nominally held by the tenant in fee of the Crown or some manorial lord, and in some cases subject to a quit or chief rent, is freely alienable either by will or by grant or conveyance *inter vivos*. The ancient burdens of knight's service, such as homage, wardships, aids, and fealty, were abolished by the statute of 1660 (12 Car. II, c. 24). If the tenant in fee dies without a will and without heirs lineal or collateral, the land will escheat to the lord of whom they were held. Besides freehold tenure, land may be held by copyhold tenure, and such land is subject to peculiar incidents according to the custom of the manor, and is alienable by surrender and admittance (see art. COPYHOLDS). Land may also be held for a term of years, and the interest thereby created is called a chattel or personal interest. Terms of years may be created by leases, subject to a yearly rent and seldom exceeding ninety-nine years. Leasehold estates are considered personal property, and, subject to the restrictions of the lease, are alienable by will, or *inter vivos* by assignment or sub-lease. In the case of the death and intestacy of the lessee, his interest passes to his personal representatives. See art. LEASE. [A. J. S.]

Land Leveller.—Land levellers are used frequently to produce a level surface on land being laid out for irrigation, or when excavating on higher land to bring a lower piece up to the same level. Where the distance of removal is short but lies over a considerable area, a multiple plough does good work if used over the same ground a number of times to turn the soil in one direction. The Shuart land grader or leveller is a good form of leveller to bring about a smooth level surface for irrigation purposes. The illustration shows its method of working, and the control of the depth of working. Inequalities are filled in by soil being scraped to them, or if it is desired to take the soil to a distance the pitch of the scoop can be altered for this. Simple land levellers can be made on the principle of the triangular snow plough. The horse scoop for excavating soil to be removed to a distance beyond which it can be thrown has been in use in England for more than a century, but is far more rarely seen than its efficiency and economy warrant. One man can move many yards of soil to a considerable distance in a day, no shovelling being necessary as it is both self-filling and self-emptying, the filling being done as the horse draws the scoop into the soil. By pressing the handle the soil scooped in is conveyed to its destination on its runners, while another pressure causes it to empty itself. [W. J. M.]



Shuart Land Grader or Leveller

Landlord.—Originally, it may be presumed, a landlord, as the name denotes, was simply the lord or owner of land, as distinguished from the person or persons who held it under him. But the term has been extended to tenants who sublet land, to owners of houses and other buildings who let them, to tenants of such buildings who sublet them or parts of them, to owners and tenants of houses who take in lodgers, and to innkeepers, whether owners or tenants of the houses they occupy. In short, there are head landlords and under landlords. In this country the reigning sovereign is the supreme landlord, and although this has been often described as a legal fiction, it has much importance in relation to the right of the State to take land for public purposes, after paying fair compensation for it. The responsibilities of agricultural landlords vary greatly in different countries and parts of countries. In Great Britain the landlord usually provides the farmhouse and buildings, and more or less commonly makes other permanent improvements; but in the crofting districts of Scotland and partially in Ireland this is not the case. Moreover, the extent to which landlords carry out such permanent improvements as that of draining land varies greatly even where they provide all buildings, and in many cases agricultural leaseholders have sunk much capital in buildings. Under the metayage system, which prevails in parts of some European countries, the landlord sometimes provides implements and live stock, in addition to buildings, sharing in the produce or money returns of the farm with his tenant.

The history of the relations of lords of the soil to those who have held under them has been largely one of oppression and injustice, very slowly and by small steps righted to a great extent, but not even yet completely. (See art. TENANT RIGHT.) The character of a landlord or the traditional policy of his family has always had a great effect upon the financial position and general welfare of his tenants.

On many large estates in England, and in Scotland, the landlords have been lenient in the exaction of rents, and generous in times of misfortune; while others have been as harsh, exacting, and mean. As a rule, an agricultural landlord obtains a very small rate of interest upon the capital invested in his estate, and in many a case, since agricultural depression set in, the net returns have been little or nothing. In consequence of the low terms upon which a landlord's capital is usually invested in a farm, and the share which he often bears in losses due to bad times for farming, the landlord-and-tenant system is strongly supported by the majority of farmers. But in past prosperous times farm rents advanced by leaps and bounds, much of their increase having been due to the improvements of tenants, only recently protected by law to any considerable extent. The long-lease system, common in Scotland, by the attraction which it has possessed for men of capital and enterprise, has tended in no small degree to advance rents. On some English estates, where yearly tenancy prevails, rents have not been altered for a generation or two, even when they were commonly rising, and the tenants have had practically fixity of tenure so long as they paid their rents. In too many cases, however, such indulgence has been more or less neutralized by the over-preservation of game.

A 'ground landlord' is the owner of land upon which leasehold buildings are erected. The exactions which he often makes when leases expire, in enormous increases of rent, the execution of improvements, or even rebuilding, under so-called freedom of contract, have been so great that there is a strong public demand for the abolition of his privileges. [W. E. B.]

Landlord and Tenant. See Lease.

Land Nationalization.—Essentially the demand for the nationalization of the land is one of restitution, and not one of innovation: for, in every part of the world, the tenure of land was national, tribal, or communistic in ancient times, and it has remained so to some extent in many countries up to the present date, as in Russia under village communities, in a great part of India under the ryotwari system, and in the portions of New Zealand still held by the Maories. In our Australasian dominions, too, vast tracts of land are still owned by the State, after generations of steady alienation. Even in our own country the absolute ownership of land, in legal theory, vests in the Crown, and no private person holds more than an 'estate' in it. Throughout the greater portion of the civilized world, however, the land has become private property to all effects and purposes, and it is only in recent times that a demand has sprung up for the restoration of effective State ownership.

For generations past, writers of eminence have set forth the abuses arising out of the individual ownership of land, especially where it is held in great estates, and have shown leanings towards the restoration of State ownership, although, until recently, no distinct plan for that purpose has been devised. John Stuart Mill declared that 'the land of Ireland, the land of every country, belongs to the people of that country'; but he proceeded no further in his demands than his well-known scheme for the appropriation by the State of the unearned increment in the value of land. Froude, in his History of England, wrote: 'Land is not, and cannot be property in the sense that moveable things are property. Every human being born into this planet must live upon the land if he lives at all. The land in any country is really the property of the nation which occupies it; and the tenure of it by individuals is ordered differently in different places, according to the habits of the people and the general convenience.' Professor F. W. Newman said that 'to make away into mercenary hands, as an article of trade, the whole solid area on which a nation lives is astonishing as an idea of statesmanship'. Herbert Spencer, who showed strong leanings towards land nationalization in his Social Statics, but repudiated them in the latter part of his life, wrote: 'It may by and by be perceived that equity utters dictates to which we have not yet listened; and men may then learn that to deprive others of their rights to the use of the earth is to commit a crime inferior only in wickedness to the crime of taking away their lives or personal liberties'. Mr. Gladstone, in a speech at West Calder in 1879, said. 'In my opinion, if it is known to be for the welfare of the community at large, the Legislature is perfectly entitled to buy out the landed proprietors. . . Those persons who possess large portions of the earth's space are not altogether in the same position as the possessors of mere personalty. Personalty does not impose limitations on the action and the industry of man and the wellbeing of the community, as possession of land does, and therefore I freely own that compulsory expropriation is admissible, and even sound in principle.'

The origin of the existing movement in favour of land nationalization may be traced to the publication, in 1879, of Mr. Henry George's wonderful work, Progress and Poverty. This book was first published in the United States, but speedily acquired a large circulation in this country, and an English edition was issued at a low price in 1881. As the work of a self-educated man, it is rightly described as wonderful, not only in respect of the eloquence and power of its arguments, but also with regard to the grasp of the subject which it displayed, and for the aptness and felicity of its numerous quotations. In this work for the first time the evils arising from the individual ownership of land were fully set forth, and the rhetorical exaggerations which filled many of its pages rendered it all the more fitted to excite attention among the public at large.

It was through observing the advance in the private ownership of land in California, accompanied as it is in all new countries with wholesale land-jobbing, that Mr. George was first led to connect destitution with it. He saw that, as the land got taken up, wealth and pauperism alike increased, and he was thus induced to study the effects of private land-ownership on a wider area. Ignoring other causes, he came

to the conclusion that the subject of his study was everywhere *the* cause of the distressful poverty that grew in extent even where wealth was most rapidly increasing, and hence he was led to the further conclusion that the private ownership of land was a wrong to the community, and should not be permitted. A limited number of individuals, he maintains, have no more right to monopolize the land, without which the human race cannot exist, than they have to appropriate all the air, without which we cannot breathe. The effects of the system he condemns in thickly and sparsely populated countries, in towns and rural districts, are forcibly stated, as showing that rent everywhere absorbs a very large proportion of the profits of enterprise, and further checks enterprise that, without it, would be undertaken. By 'rent', it must be explained, Mr. George means the rent of the bare land, apart from buildings and other improvements upon it. The appropriation by the State of landowners' improvements, he declares, would be both immoral and inexpedient: immoral, because there is no natural right more clearly established than the right of a man to the fruits of his labour; inexpedient, because such spoliation would check industry and thrift, and thus injure the community. But to take the bare land, which belongs equally to every man born, he contends, is not only justifiable and expedient, but also essential to the general wellbeing.

So far in his argument Mr. George probably carries the great majority of his readers with him, at least as to the right of the State to take the land, while difference of opinion prevails as to the terms of its acquisition and as to the expediency and essentiality of that proceeding. This right is not only generally admitted, but has been acted upon for generations for various public purposes. Unfortunately Mr. George vehemently maintains that compensation is not only not required by justice, but that the State would be wrong to give it. The original appropriators of land, he argues, were robbers, and they and their successors have been defrauding the rest of the community ever since. Therefore, to compel the present holders of land to give up their wrongful possessorship without demanding the restitution of land revenues improperly appropriated in the past would be to let them off easily, and to compensate them would be to recognize a vested interest in robbery. Try the case, he adds, by the maxims of common law, said to be the perfection of reason. If land possessed by A is proved to belong to B, although A may have purchased it in perfect innocence, the law does not compensate A, but puts B in possession, while A loses all his improvements, as well as the land, and may further be called upon to account for the profits of the estate during the time that he held it. Apply the same law in the case of the People *v.* the Landowners, Mr George goes on to say, and, instead of paying compensation for the land, the nation will take the improvements as well. So far, as already stated, Mr. George is not disposed to go. 'It is sufficient for the people', he says, 'to resume the ownership of the land. Let the landowners retain their improvements and personal property in secure possession.'

This, in brief, is Mr. George's argument for what he frankly admits to be confiscation, and it has done more than any objections raised by opponents to the scheme of land nationalization to wean public sympathy from that object. His illustration of what he regards as a parallel case is not a true comparison. A would be dispossessed of his estate without compensation, because the law never sanctioned his possessorship, whereas the law does sanction separate property in land, and has sanctioned it for generations, although, theoretically, in this country, the Crown is the only absolute owner. Nor is this all; for the people have equally sanctioned what the law has permitted, not one person in a thousand, until quite recently, having uttered a protest against individual land-ownership. It has even been regarded as meritorious for a man to save money to invest in land; quite recently British taxpayers have been called upon to incur a great sacrifice in order to make the farmers of Ireland the individual owners of the land they till; and large numbers of persons, including many leading politicians, are strong advocates of the establishment of a peasant-proprietary in Great Britain. Surely, then, for the nation suddenly to turn round upon the landowners with a demand for the restoration of the land without compensation would be an outrage upon justice and consistency alike. Even persons who would not show any mercy to the owners of large estates, in spite of the facts that they are holders of property that is no more the result of robbery than a large proportion of the great fortunes in personalty are, and that a great number of mortgagees and others are interested in the land, would shrink from confiscating farms or small holdings acquired by people who purchased them with hard-won earnings.

It remains to notice the stupendous anticlimax into which Mr. George was led in the concluding portion of his work, when he came to propose a practical scheme of legislation. Having decided that the only effectual remedy for the recurring paroxysms of industrial depression, the scarcity of employment, and the tendency of wages to the starvation point is to make the land common property, Mr. George gave up the idea of land nationalization altogether. 'We should satisfy the law of justice,' he says, 'we should meet all economic requirements, by at one stroke abolishing all private titles, declaring land public property, and letting it out to the highest bidders in lots to suit, under such conditions as would sacredly guard the private right to improvements.' But he proceeds to argue that such a plan would be a needless shock to present customs and habits of thought. and a needless extension of Government machinery, which are to be avoided. Therefore, he says: 'I do not propose either to purchase or to confiscate private property in land. The first would be unjust; the second, needless. Let the individuals who now hold it still retain, if they want to, possession of what they are pleased to call *their* land. Let them

continue to call it *their* land. Let them buy and sell, and bequeath and devise it. We may safely leave them the shell, if we take the kernel. It is not necessary to confiscate land; it is only necessary to confiscate rent. . . . We already take some rent in 'taxation'. We have only to make some changes in our mode of taxation to take it all.' Thus Mr. George gave up the idea of the nationalization of the land, in favour of its exhaustive taxation, which, in the opinion of many land nationalizers, would render the evils arising from private ownership in land worse than they have ever been hitherto.

The first real scheme of land nationalization was initiated by Dr. Alfred Russel Wallace in an article entitled 'How to Nationalize the Land: a Radical Solution of the Irish Land Problem', which appeared in the Contemporary Review for November, 1880. The publication of this article gave rise to the Land Nationalization Society, which was founded in 1881, with Dr. Wallace as president. In this article for the first time it was shown how all the supposed difficulties of State management in the event of the nationalization of the land could be overcome. It is not necessary to allude further to this article, because Dr. Wallace's scheme was more fully set forth in his Land Nationalization, published in 1881.

Dr. Wallace's scheme may be briefly described as follows. All land, apart from buildings and other improvements, to become the property of the State, present owners being compensated by terminable annuities, in exchange for which the State would take quit-rents (or ground rents) from the occupiers. The tenant-right (improvements) would belong to the occupiers, after they had purchased the portion which had not been carried out by them. The duration of the terminable annuities is described as a matter of detail, though it is suggested that it might be for two lives, the life of the owner and any heir born before his decease. The amount of each annuity would be determined by valuing the bare land, apart from improvements upon and in it; and the value of the tenant-right would be ascertained at the same time and in the same way. Of course, an annuity would not in any case be more than the quit-rent, and the aggregate of the annuities could never be more than the aggregate of the quit-rents, unless the value of the land of the country as a whole should become reduced; while, as the annuities expired, the State would obtain the quit-rents as pure gain. At intervals the quit-rents would be revalued, in order to secure the unearned increment for the nation, but avoiding the renting of any property rightfully belonging to the occupiers. Landowners would be allowed to retain their estates, or any portions of them, provided that they occupied them and paid the quit-rents to the State; but no subletting would be permitted, because one great object of the reform proposed would be that of removing the evils inseparable from 'landlordism'. Such portions of their estates as landowners would not choose to occupy would be held by existing or future occupiers, who would purchase the tenant-right belonging to the owners. Conversely, any tenant-right belonging to occupiers of land which the owners would choose to take into their own hands would have to be paid for by the owners. Tenant-rights would be saleable and heritable property, and subdivision of holdings would be permitted under proper regulations for apportioning quit-rents. No more State management than is necessary at present for the collection of taxes on land would be necessary. Indeed it is contended that, as one assessment of land-values would be sufficient for all purposes, existing State officialism might be reduced. As annuities fell in or unearned increment occurred, taxes would be reduced, and ultimately, it is sanguinely suggested, all taxation besides quit-rents might be abolished. To enable farm labourers and others to acquire plots of land, Dr. Wallace tacks on to the main portion of his scheme a proposal in favour of free-selection similar to that current in Australia, which is a matter of detail that need not be discussed.

Dr. Wallace has adhered to his original plan with little if any modification, although other leaders of the Land Nationalization Society prefer the payment of compensation to landowners in Government land bonds, instead of in terminable annuities. The plan of purchase by means of bonds was suggested many years ago by the late Mr. Michael Davitt, and it was thoroughly worked out by Mr. Charles Wicksteed, one of the vice-presidents of the Land Nationalization Society, in The Land for the People, while it is concisely and clearly set forth in State Land Purchase, by Mr. Joseph Hyder, secretary of the Society, by which both essays are published, at 432 West Strand, London. Land bonds bearing interest at 5 per cent per annum would be issued to the amount of the selling value of the land apart from improvements at the time of transfer to the State. Mr Hyder adds, 'after the operation of an equitable tax on land values has pricked the inflated prices which now prevail as the result of the unfair exemption which landed property now enjoys'. This takes off the appearance of equity from the plan, seeing that rural land at least is enormously overrated already. Such a detail, however, can hardly be regarded as an essential part of the scheme. The quit-rents to be paid by holders of land in the first instance would precisely balance the interest on the bonds, and as the unearned increment increased, a sum for the gradual redemption of the bonds would be accumulated. Mr. Hyder is sanguine enough to assume that the unearned increment would be at least 1 per cent per annum. He would have quinquennial revaluations of the land, but neglects to take their enormous expense into account. According to his calculations the bonds would be all redeemed in sixty-seven years, with a considerable balance of surplus. In the event of the unearned increment not proving sufficient for the redemption of the bonds, it is suggested that a special tax on large incomes and part of the death duties might be made available for the purpose. Without attempting to examine the financial soundness of the plan, it may be said that it is more equitable than that of terminable annuities,

because the bonds would be redeemed by payments to their holders, whereas the annuities would lapse at their termination without any payment. Moreover, bonds could easily be distributed among the several persons pecuniarily interested in an estate in proportion to their several shares.

Among the members of the Land Nationalization Society there are some 'single taxers', as the disciples of Mr. Henry George are called, and Mr. Hyder, without any protest against the injustice of the gradual confiscation of land values, devotes a considerable portion of his pamphlet to an argument showing that the process would not only excite the strongest possible opposition, but would also be much less advantageous to the nation than one of compensation. Under the taxing-out plan the land would remain the property of the owners for an indefinite period, and in the meantime the worst abuses of 'landlordism' would be increased. Further, Mr. Hyder points out that one result of the tax would be a great multiplication of landowners, as the possessors of many large estates would be constrained to put them, or parts of them, into the market. Then the number of landowners might be sufficiently increased to give them the power of preventing the further taxation of land.

Probably the great majority of land nationalizers are in favour of Dr. Wallace's plan, modified by the substitution of bonds for terminable annuities. If the idea of land nationalization is to be entertained at all, it is difficult to imagine a scheme more equitable and effective; and if there is to be no end to the hostile and merciless attacks upon landed property, and the constantly increasing inroads upon it, a time may come when the landlords themselves will welcome a scheme of this kind, as a refuge against insidious and gradual impoverishment.

[W. E. B.]

Land Presser. See FURROW PRESSER.

Landrail. For a description of this bird see art. CORNCRAKE.

Landscape Gardening. See art. GARDENING, LANDSCAPE.

Lands Clauses Acts.—While theoretically a man is the absolute owner of the land he possesses, the State has always claimed the right to retake it for purposes of public utility, on the ground that 'the exclusive right of a landowner yields wherever public interest or necessity requires it should yield'. But no private individual or corporation has the right to acquire compulsorily land belonging to another without the sanction of Parliament. Consequently, towards the end of the 18th and in the early part of the 19th century, when increasing trade and the necessity for communication led to the promotion of great schemes for the formation of canals, railways, &c., Parliamentary assistance had to be invoked in order to acquire the requisite facilities. In order to avoid the necessity of printing clauses giving compulsory powers, &c., in each private Act, and also to promote uniformity in the methods adopted, a series of Acts known as the Lands Clauses Acts has been passed, the foundation of which are the Lands Clauses Acts of 1845. These Acts apply to every undertaking authorized by Parliament to take land for the purposes of the undertaking, and all the provisions of these Acts, save so far as they are expressly varied or excepted by the private Act, shall, so far as applicable, apply to the undertaking. Separate Acts applicable to England and Scotland respectively were passed in the same year, and though they differ in some points, their provisions are in the main to the same effect.

ACQUISITION BY AGREEMENT.—The first division of these Acts contains clauses making provision for the purchase of land by agreement, and for enabling parties having limited rights or under disability to sell and convey lands to the promoters.

COMPULSORY ACQUISITION.—The next division of the Acts provides for the purchase of lands otherwise than by agreement, and it is provided that before the compulsory powers can be put into force, the whole of the capital of the company or estimated sum for defraying the expenses of the undertaking must be subscribed, as evidenced by the certificate of two justices, or in Scotland of the sheriff, to that effect. The lands proposed to be taken compulsorily can only be such as are required for the purposes of the Act, that is to say, for the construction of the undertaking described in the special Act and the various works necessarily connected therewith. The compulsory powers cannot be exercised after the expiration of the period prescribed in the special Act, and if no period be prescribed they cannot be exercised after the expiry of three years from the passing of the special Act.

NOTICE TO TREAT.—The first step to be taken by promoters proposing to acquire land compulsorily is to give notice of their intention by the document technically known as the 'Notice to treat'. This notice must demand particulars of the interests possessed, and the claims made in respect thereof, and shall further state the particulars of the lands required, and that the promoters are willing to treat for the purchase thereof, and as to the compensation to be made for the damage which may be sustained by reason of the execution of the works. This notice requires to be served on the parties interested, either personally, or left at their last known place of abode; and in the case of parties absent from the kingdom or who, after diligent enquiry, cannot be found, such notice may be given to their factor or agent, and shall also be left with the occupier of the lands, or failing an occupier, shall be affixed upon some conspicuous part of the lands. This notice has the effect of forming a binding contract between the parties from which neither can resile (except in the case where it relates to a part only of a house, &c.—see below), for although the price and the other conditions of the contract remain to be decided, the notice is of itself sufficient to make a binding contract, and the subsequent provisions of the Act only relate to the ascertainment of the price and the assessment of the compensation due. The company, therefore, cannot take less than the amount of land which

they have demanded, nor, on the other hand, can they take more, except by serving a supplementary notice, which of course must be served within the period prescribed, as already explained.

Intersected Lands.—Generally speaking, the promoters are not entitled to take more land than is absolutely required for the purposes of their undertaking; but in the case of lands not situated in a town or built upon, which are so intersected by the works as to leave either on both sides or on one side a less quantity of land than half an acre, the promoters must purchase same if so required, unless the owner has other land adjoining into which the intersected portion or portions may be thrown. In any event, if this is done, the expense of removing fences, levelling sites, &c., must be borne by the promoters. On the other hand, the promoters may insist on purchasing such small portions of intersected land where the expense of making bridges or other communications exceeds the value of the land. This latter provision applies to all severed lands, and is not restricted to lands not situated in a town or built upon.

Leasehold Subjects.—In the case of land subject to leases, it is provided that where part only of the land under lease is taken, the rent is apportioned between the lands taken and the lands not taken, either by agreement between the owner and the occupier on the one hand, and the promoters on the other, and failing agreement, by two justices, or in Scotland by the sheriff. Thereafter the lessee is liable only for the rent apportioned in respect of the land not required for the purposes of the undertaking, otherwise all the conditions of the lease remain in force. Not only is the proprietor entitled to be compensated for the land taken, but tenants are also entitled to be compensated for damage done to them in their tenancy by reason of severance of the lands required from those not required, or otherwise by reason of the execution of the works.

Acquisition of Part only of a House, &c.—No party can be compelled to sell to the promoters a part only of any house, building, or manufactory if such party be willing and able to sell and convey the whole thereof. If he is unwilling to part with a portion of the property, he is entitled to serve a counter notice on the promoters refusing to sell the part claimed and offering the whole. The company are not obliged to take the whole, and may abandon the purchase altogether. In this case the notice to treat does not, as in ordinary cases, constitute a completed contract from which the company is not entitled to resile. The term 'house' includes the ground on which it stands, and has also been held to include a garden attached to it. This provision is, however, frequently relaxed or varied in the special Act authorizing the undertaking.

Entry on Lands.—Except by consent of the proprietor and occupier, the promoters cannot enter on lands proposed to be taken until they have paid or deposited in bank the price, and settled with all parties interested. By entry on the lands is meant such actual work as cutting the ground or driving a tunnel. It is, however, provided that for the purposes of surveying and taking the levels, setting up the line of work, &c., the promoters may without consent enter on the land, provided.—

1. They give not less than three nor more than fourteen days' notice to the owners and occupier, and

2. Make compensation for all damage caused

Land for Temporary Purposes in the Case of Railways.—In order to the construction of the undertaking it may be necessary for the promoters to obtain ground for the erection of the necessary workshops, depositing spoil, &c., for which purpose they are entitled (by the Railway Clauses Acts) to the temporary use of ground adjacent to that taken for the line, provided it be not more than 200 yd from the centre of the railway, nor nearer to any mansion-house than 500 yd. Gardens, orchards, ornamental pleasure ground, &c., cannot be taken The company is entitled not only to the use of the surface of the ground, but may quarry stone or remove material which they require in connection with the construction of their railway, unless the ground is already being worked as a quarry. Three weeks' notice must be given to the proprietor, who may object to the promoters making use of the lands, on the ground that other lands lying contiguous would be more suitable. Before using such temporary land, the promoters are bound to separate the same by a sufficient fence from the adjoining lands. The proprietor or party interested may require the promoters to purchase the land outright The promoters are also entitled to occupy temporarily private roads within 500 yd. of the railway, provided they are not avenues or ornamental approaches to any mansion-house, on three weeks' notice and on payment of compensation. The owner or occupier of such roads is entitled to object on the ground that other roads should be taken, and in every case where the promoters make use of roads so as to render them impassable or dangerous to passengers or carriages, they must substitute and maintain sufficient roads in place of those taken.

Superfluous Lands.—The promoters are only entitled to hold lands which are absolutely necessary for the purpose of their undertaking, but they may find themselves in possession of property which is not required for the purpose of their Act. This may arise:—

1. Through the land having been bought for a purpose which is afterwards changed.

2. The promoters may have been compelled to purchase portions of intersected land, or property of which a part only was required.

3. They may have been compelled to purchase land which they required for temporary purposes only.

With respect to such lands, it is enacted that they must be sold within the period prescribed by the Act, or within ten years after the expiration of the time limited for the completion of the works, and the purchase money applied for the purpose of the undertaking. In the event of the land not being sold within such period, it shall, immediately on the expiry, vest in and

become the property of the owners of the land adjoining thereto, in proportion to the extent of their lands respectively adjoining. Except in the case of superfluous lands which are in a town or built upon, or used for business purposes, the promoters, before disposing of such superfluous lands, must offer them to the proprietor of the ground from whom the lands were originally taken, and if he refuse to purchase or cannot be found, then they must offer them to the proprietor of the lands immediately adjoining the superfluous lands.

ASSESSMENT OF COMPENSATION.—Where the purchase money or compensation cannot be settled by private arrangement, the Act makes the following provisions for its ascertainment:—

1. Where the claim does not exceed £50, or in the case of a tenant who has no greater interest than for a year or from year to year, the compensation shall be determined in England by two justices and in Scotland by the sheriff.

2. If the claim exceeds £50, or in the case of a tenant who has a greater interest than for a year or from year to year, by arbitration in the option of the claimant.

3. If the claim exceeds £50 and the claimant does not elect for arbitration, or if he fail to state his claim timeously, or if the arbitration lapses through delay, the compensation shall be settled by a jury.

4 Where a person, through disability or incapacity, or by reason of absence from the kingdom, is prevented from treating, or after diligent enquiry cannot be found or shall not appear at the time appointed for jury trial, the compensation shall be determined in England by surveyors appointed by two justices, and in Scotland by a valuator appointed by the sheriff. In the case of absence the owner on his return may challenge the valuation and have it remitted to arbitration.

All the expenses of the arbitration and incident thereto shall be borne by the promoters of the undertaking, unless the arbiters or oversman award the same sum as, or a less sum than shall have been offered by the promoters of the undertaking, in which case each party shall bear his own expense, and in all cases the expenses of the arbiter or arbiters and oversman, as the case may be, and, in Scotland, of recording the decree arbitral, shall be borne by the promoters of the undertaking. [D. B.]

Land Steward. See arts. AGENT, LAND; and BAILIFF.

Land Surveying. See art. SURVEYING.

Land Tax.—1. ENGLAND—The usual method of raising revenue for State purposes in earlier history was by means of subsidies or so-called benevolences, but in 1689 (1 Will. & Mary, c. 3) a land tax was imposed, originally at the rate of 3*s.* in the £ on the rental, which in 1692 was raised to 4*s.* per £, while a tax of 24*s.* per £100 was imposed on personal estate. In 1698 there was substituted a fixed sum called the land tax, to be collected from the various districts into which the country was divided, in the proportions stated in the Act. The tax never applied to Ireland, but in 1707 it was extended to Scotland, and the relative proportions payable by the two kingdoms fixed. From this time forward the tax was voted annually until 1798, when it became permanent, the English quota being fixed at the sum of £1,989,673, 7*s.* 10*d.*, and the maximum rate fixed at 4*s.* per £, at which rate it continued until 1896, when it was lowered to 1*s.* per £. The total amount fixed was levied on the different districts—parishes and boroughs—in accordance with the divisions specified in the Act (38 Geo. III, c. 5), and the amount collected by the land-tax commissioners. The tax may be redeemed in conformity with the provisions laid down by statute.

2. SCOTLAND.—Prior to the middle of the 17th century the national taxation, when imposed, was levied to the extent of one-half on the church land, one-third on the freeholders, and one-sixth on the burghs. After the annexation of the church lands by the Crown in 1587 the quota contributed by the counties was preserved, while the remainder of the tax was imposed on the rest of the kingdom. Later, the plan was adopted of imposing on each sheriffdom and burgh throughout the kingdom a certain amount, and the allocation of the amount payable by the several lands, and the collection thereof was entrusted, in the case of counties, to commissioners expressly named, and in the case of burghs, to the magistrates. For a considerable time prior to the Union, the tax—under the term cess or land-tax—had been regarded as an annual one, and after the Union it continued to be imposed by Annual Supply Acts until 1798, when, as already pointed out, the tax was made perpetual for both kingdoms. In 1797 the Scotch quota had been fixed at £47,954, 1*s.* 2*d.*, at which sum it became stereotyped by the Act of the following year. The tax is now payable entirely by counties, for by the provisions of the Agricultural Rating (Scotland) Act it was abolished so far as burghs are concerned. The amount assessable in each county and allocated on the particular lands therein has long ago been fixed by the Cess Books and Acts of Parliament. The power of redemption is the same in Scotland as in England, and this power has been so far availed of by proprietors, that about one-third of the whole amount originally fixed as Scotland's quota has been redeemed.

Where, in England or Scotland, the owner in possession of rents and profits of any land or other property on which land tax is assessed, before the amount so assessed in any financial year is paid, produces to the collector of land tax, evidence that his total income does not exceed £160, he shall be exempt from payment of land tax; and on production of evidence that his total income does not exceed £400, one-half of the land tax shall be remitted. [D. B.]

Land Tenure.—Seeing that the land is the great original source of wealth—using that term in its widest sense—all the world over, it is obvious that the conditions under which it is held are of the utmost importance to the people of every country.

The ideal system of land tenure, if it may be assumed that any single system would fulfil the requirements, is that which would conduce most thoroughly to the development of the resources of

the soil, to the prosperity of the productive industries other than that of agriculture, and to the wellbeing of the masses of the people in towns, as well as in the rural districts. But there is much difference of opinion as to which system would be most conducive to the attainment of these objects. There are numerous advocates of occupying ownership, the landlord-and-tenant system, and the nationalization or municipalization of the land respectively. The first set of thinkers contend that no other system than that of occupying ownership can afford as complete and unequivocal security to capital in land, whether it be used agriculturally or as the sites of manufactories, shops, or dwelling-houses. The chief objections made to it by others than those who object to the private ownership of land entirely are the disadvantage of sinking capital at very low interest in agricultural land, the tendency to excessive subdivision which it fosters, the poor farming frequently resulting from the withdrawal of capital from farming, and the propensity of landowners to burden their estates, even when quite small, with family settlements; also that the working classes, who are largely migratory, cannot conveniently own their houses, including the sites, even if the capital for purchasing them is available. In this country the extravagant expense of land transfer and mortgaging seriously enhance some of these objections. If these abuses were removed, a farmer would probably do better by purchasing and mortgaging a holding than by renting it, presuming that land is more likely to rise than to fall in value. It is true that with a given amount of capital he would not be able to purchase and farm as much land as he could hire, because he could not mortgage his farm up to its entire cost as a rule; but he would enjoy complete security for improvements, and, if these were made with good judgment, his profits might be greater than those which he would secure for a larger rented area.

Advocates of the landlord-and-tenant system point to the advantages of having landlord's capital at low interest invested in buildings and other permanent improvements, of being able to farm a larger area of land with a given amount of capital than an occupying owner could manage, of relief from landlord's taxes, and of participation by landlords in losses caused by agricultural depression. The objections to the system from an agricultural point of view are that a tenant, even under the best of laws for the security of tenant-right, cannot enjoy the full security of ownership; that he is liable to eviction at the caprice of his landlord; and that there is frequently a set-off to any indulgence in respect of rent in the form of damage by game preserved excessively.

Those who are in favour of the nationalization or municipalization of the land object to the private ownership of land, whether it be occupied by its owners or let to tenants. They contend that the increment in the value of land arising from circumstances other than the improvements of users of it should be secured to the people at large, and they complain of the exorbitant prices charged for land required in or near towns and villages for building purposes. Further, they point out that occupiers of land hired from the State or from municipalities could be provided with at least as good security for improvements as could be afforded under the existing landlord-and-tenant system, and better than under any other plan than that of free sale of tenant-right, which their system would allow; also that all the advantages of occupying ownership except the right to the unearned increment in the value of land would be provided by allowing occupiers to sell or bequeath their right of occupancy and improvements. The chief objections made to this scheme are that it would involve a tremendous financial undertaking, and upset the social system of the rural districts, in many respects beneficial; that public authorities would probably prove harder and less sympathetic landlords than the majority of individual landowners are; and that there would be as much risk of injustice from authorities in the periodic revaluation of holdings for assessing the increment or decrement as there is in the valuation of tenants' improvements. For details on this branch of the subject see art. LAND NATIONALIZATION.

UNITED KINGDOM.—In Great Britain the prevailing system of land tenure is that of landlord and tenant. In 1907 the extent of land rented in holdings over 1 ac. was 28,311,416 ac., and that which was owned by the occupiers was 3,932,031 ac., out of a total of 32,243,447 ac. under crops, grass, and fallow. Neither smaller holdings than 1 ac. nor mountain and heath grazing lands are included in the Agricultural Returns, while woodlands are given separately at intervals of some years. The proportions are 87·8 per cent of land rented and 12·2 per cent of land owned by the occupiers. The proportions owned by occupiers in the three main divisions of Great Britain do not differ widely. They are 12·4 per cent for England, 10·4 for Wales, and 12·3 for Scotland. The latest return of the numbers of occupiers of over 1 ac. in Great Britain who owned and rented these holdings respectively is that of 1895. Out of a total of 520,106 returns of holdings, 439,405, or 84·5 per cent, were from occupiers renting all the land they held; 61,014, or 11·7 per cent, from those who owned their entire holdings; and 19,687, or 3·8 per cent, from those who owned part and rented part of the land they farmed. Much of the land occupied by owners consists of farms thrown upon the landlords' hands, and as the number of unlet farms was much smaller in 1907 than in 1890, the area of land occupied by owners had been reduced by 911,477 ac. between the earlier and the later years. It may be assumed, therefore, that the number of occupying owners is smaller now than it was in 1890.

There are no statistics showing the proportions of farms respectively let under leases and yearly tenancy. It is well known, however, that leases are exceptional in England, and common in Scotland. They have been greatly reduced in number in England since agricultural depression set in. In Ireland, until a comparatively recent date, occupying owner-

ship was very uncommon, all but a small proportion of the holdings having been held on yearly tenancy, although leases had been numerous in the early portion of the last century. Since the first Land Purchase Act was passed, however, tenants have been steadily acquiring the ownership of their farms, and the process has been greatly accelerated by the latest Act of this kind. See art. IRISH LAND ACTS.

Objectors to the private ownership of land have a strong point in their favour in one of the abuses of that system of land tenure in this country. The large estates are generally held under strict entail or settlement, existing holders being merely life tenants. Modern legislation has mitigated the disadvantages of limited ownership in relation to expenditure by a life tenant upon estate improvements, which formerly it was entirely against his interest to carry out, as well as in reference to leases and other agreements. Recent cases decided in the law courts of Scotland, however, have afforded fresh illustrations of the insufficiency of that remedial legislation, showing that a tenant in tail is at liberty to repudiate agreements made by his predecessor in title unless they are within certain narrow limits. Further, it is reasonably complained that the law of entail and the custom of primogeniture are monstrously unjust to all members of the landowner's family except the eldest son or other heir to his real estate. Such abuses, however, are not necessarily inherent to the personal ownership of land. This may also be said of our cumbrous and costly system of land transfer, which has no parallel in any other part of the world.

Ownership of land in common, at one time extensive in its scope in this country, has now been reduced within extremely narrow limits. That the system had serious disadvantages no one acquainted with farming will deny, and it may be said that it is the method under which commons have been enclosed, rather than enclosure itself, which renders the history of enclosure highly discreditable to lords of manors and legislators of the past. In many cases the commons were simply confiscated, and even where the commoners were compensated, the allowance was not equitable as a rule. If in land, the area was too small, and if in money, it was in all respects unsatisfactory, because the existing generation of commoners had no right to dispose of the land, which should have been regarded as the property of their descendants as much as of themselves.

FRANCE.—In most of the countries of Continental Europe the disadvantages of the private ownership of land are mitigated by its wide distribution among the people. In France, peasant proprietors were numerous for centuries before the Revolution, but they have been multiplied continuously since the Code Napoléon rendered the equal division of a landowner's property in land among his children, excepting only a single share equal to that of each of the children, as to which he has freedom of disposal. That this law has done harm by causing an excessive subdivision of landed property cannot be disputed; but family arrangements have counteracted this evil to a great extent, as also has the eagerness of the peasant proprietors to increase the area of their holdings, so far as their means allow, whenever land in their vicinity comes into the market. Moreover, much may be forgiven to a law which renders impossible the injustices of entail and primogeniture. The latest official statistics of the distribution of land in France are those of the special enquiry made in 1892, and published in 1898. The figures are given in some detail in the article EUROPEAN AGRICULTURE, but may for convenience be summarized here as follows:—

	Acres	Per cent
Area cultivated by owners . .	45,261,200	52·8
Area cultivated by ordinary tenants	31,193,100	36·4
Area cultivated by metayers..	9,304,400	10·8
Total cultivated area .	85,758,700	100
	Number.	**Per cent.**
Holdings cultivated by owners	4,190,795	74·6
Holdings cultivated by ordinary tenants	1,078,184	19·2
Holdings cultivated by metayers	349,338	6·2
Total number of holdings	5,618,317	100

These figures may be compared with those given above for Great Britain, bearing in mind, however, that the French figures cover holdings of the smallest size, whereas the British statistics are restricted to holdings over 1 ac. In France, as in Great Britain, there is a survival of communal land tenure in the form of land held in common; but in neither country, apparently, is this considered of sufficient importance to be dealt with in the agricultural statistics. One of the chief disadvantages of the French land system consists in the scattered positions of plots of land held by the same peasant proprietor. Efforts have been made in recent years to rectify this great disadvantage by inducing neighbouring owners of isolated plots to make exchanges, so as to bring their properties severally within a ring fence, so far as possible. The scattering of plots of land is indicated, but not fully shown, in the figures given in the art. EUROPEAN AGRICULTURE in relation to the number of owners of land as compared with the much larger number of holdings occupied by owners. To the same article readers are referred for some details of the sizes of holdings. The system of land transfer in France is simple and expeditious, but not cheap, as, in addition to varying legal expenses, there is, unless it has been recently abolished or reduced, a duty of over 6 per cent on each transfer.

SWITZERLAND.—The neighbouring country of Switzerland is one in which peasant proprietorship largely prevails. With respect to Spain and Portugal, some details upon the various systems of land tenure which prevail in these countries are to be found in the art. EUROPEAN AGRICULTURE. Spain, it is to be remarked, is one of the few countries in which great ancestral estates have been maintained almost without abatement.

BELGIUM.—In Belgium, less than half the land is cultivated by its owners, and the rest by tenants who generally hold under short leases. The holdings for the most part are minute, whether owned or rented, more than half being under 3 ac. each, while the proportion over 50 ac. is very small. The average size of a holding, judging from the most recent statistics available, is under 9 ac. It is only through the wonderful industry and good farming of the peasants that the excessive subdivision of land has not proved disastrous. Belgium, however, is a very densely populated country, and there are excellent markets for the small products of the farm and the market garden, while the exports of such products are considerable. Except where the *Beklem-regt*, which may be described as a perpetual hereditary lease at a fixed rent, prevails, the position of the tenants is not at all satisfactory, as many of the landlords' estates are small, and rack-rents are common. The excessive subdivision of the land is due largely to that of holdings let to tenants, as the peasant proprietors for the most part keep their little properties intact. But sales of small portions of landlords' estates considerably add to the constant increase in the proportion of very small holdings. The system of land transfer is simple, but is, or was recently, heavily taxed.

NETHERLANDS.—In Holland the proportion of occupying owners of land is somewhat larger than it is in Belgium, or about 58 per cent of the total number. The farms are much larger, the average size of a holding being about 30 ac.; but 85 per cent of the farms are under 50 ac. The land is generally better than it is in Belgium, and the occupiers are more prosperous.

DENMARK.—The prosperity of agriculture in Denmark is in great measure attributed to the legislation which, beginning some years before the end of the 18th century, and continued at intervals up to 1904, has steadily converted a nation of tenants holding under proprietors of large estates, into cultivators mainly owning their farms or small holdings. State and communal lands first came under the operation of laws made within the last twenty years of the 18th century; and it was not until after the middle of the 19th century that further legislation brought the estates of private owners within the reach of the cultivators, who were helped to purchase their holdings by means of Government and bank loans at a low rate of interest, while still later laws increased the number of small holdings. The result has been the acquisition of ownership by a great majority of the cultivators of land. An analysis of a special official enquiry made in 1901, given by Mr. R. Y. Thompson in a paper read before the Royal Statistical Society in 1906, states that out of 249,983 holdings covering 8,896,762 ac., 34·75 per cent of the number and 87·51 per cent of the area were held on freehold or hereditary tenure; 4·20 per cent of the number and 2·72 of the area, on leases of fifty years, or for the life of the tenant and his wife; 8·34 per cent in number and 7·32 in area, on annual or short leasehold tenancy; and 2·71 per cent in number and 2·45 in area, on conditions relating to official positions or service. As there were only 6,973,200 ac. under crops and grass in 1901, exclusive of garden land, the total area given above must include, not only gardens, but also rough grazings and woodlands, and the figures given under these headings do not complete the total; as to the number of holdings, the proportion of very small ones, many being only cottage gardens, was very large in 1901, and it has increased since. In a further analysis the figures given are 68,380 holdings under $1\frac{1}{3}$ ac., averaging $\frac{1}{3}$ ac.; 65,222 of $1\frac{1}{3}$ to under $12\frac{1}{4}$ ac., averaging $6\frac{1}{3}$ ac.; 46,615 of $12\frac{1}{4}$ to under $36\frac{3}{4}$ ac., averaging $22\frac{1}{2}$ ac.; 60,872 of $36\frac{3}{4}$ ac. to under 147 ac., averaging $73\frac{1}{4}$ ac.; and 8894 of 147 ac. or more, averaging $331\frac{1}{2}$ ac. With respect to the reference to hereditary tenure, a law prohibiting the creation of any fresh entails was enacted many years ago.

SWEDEN AND NORWAY.—In Sweden and Norway also occupying ownership is prevalent, the holdings as a rule, and particularly in mountainous or wooded districts, are larger than in Denmark.

GERMANY.—Up to 1807 the feudal tenure of land had lingered on in unabated prevalence in Germany. In that year the first of the Royal edicts connected with the names of Stein and Hardenberg was issued, and successive legislation in 1811, 1816, 1821, 1836, and 1850 resulted in the extinction of servile tenure, and the conversion of the cultivators of the soil into proprietors and many rent-paying tenants. The legislation was far too elaborate to be described in this article, which is concerned only with existing land tenure, and not with the history of land tenure. In other German States a similar revolution took place during the first half of the 19th century. About 86 per cent of the land in Germany is held by its owners, and only 14 per cent by tenants. The legislation referred to above first rendered it permissible for the owner of an entailed estate to free it from the entail with the assent of his family, and afterwards gave him an unlimited right of disposing of it or any portion of it by sale or bequest. It also provided special facilities to enable labourers and others to acquire small plots of land, and very small holdings are numerous in most parts of Germany, while in other parts large farms are more common. Some details as to the sizes of holdings are given in the art. EUROPEAN AGRICULTURE.

AUSTRIA-HUNGARY.—Great estates are still numerous in Austria-Hungary, a minority of them being entailed; but, in both the main divisions of the empire, occupying owners large and small are to be found side by side with tenant farmers holding commonly under leases. In Austria large estates cover most of the agricultural area, while small properties are next in importance, those of medium size being comparatively few, as also are tenants as compared with occupying owners. In Hungary, as a consequence of State intervention, some of the great estates have been divided during the thirteen years ending 1908. In a publication issued by the Minister of Agriculture it is stated that

about 267,000 ac. had been converted into small proprietory holdings in that period by State agency, and about as much more by private initiative. The latest complete statistics are those of 1895, and they show that about half the holdings were then under 67 ac., while nearly one-third were over 1300 ac. The Minister of Agriculture states that 34·56 per cent of the land belongs to the State, the Church, owners under entail, and corporations, but that more than half this proportion consists of forest and unproductive land, so that only about 21 per cent of the fertile land is held by those owners, and much of that is common pasturage.

ITALY.—No statistics appear to be available to show the comparative prevalence of the various forms of land tenure in Italy; but those of ordinary tenancy, metayage tenancy, and occupying ownership are all in extensive operation. The laws favour the distribution of land, equal division among children, irrespective of sex, being the law in a case of intestacy.

RUSSIA.—At present land in Russia is mainly held by the State, the great proprietors, and village communities, although there are many peasant proprietors and some tenants. The emancipation of the serfs by Alexander II in 1861 was simply a restoration of freedom, and not even then a complete form of it, of which they in their old village communities had been deprived by shameful tyranny in an earlier century. But agriculture has not prospered under this socialistic form of tenure, and great efforts are now being made to effect another great agrarian change by converting the members of village communities into individual occupying owners. A comparatively small number of the great estates are entailed, and the law does not favour primogeniture.

TURKEY.—The greater part of the land in this country is owned by the State, and let to the peasants, mainly in small holdings. They pay an annual quit-rent, called a tithe, nominally about 12 per cent of the produce, but actually paid in money. They have a legal right to sell or sublet their tenancies, which are inherited by their children if held till death. This tenure is known as 'miri'. Unfortunately the tenancies are farmed out, the right of collecting the rents in a group of villages being sold annually to the highest bidder. Oppressive exactions often result from this arrangement, and although a tenant has a right to insist on paying his rent in produce, which the tax-farmer does not like, he may often be too much in subjection to assert himself to this extent. Some estates are held by charitable institutions, which simply take the place of the State in relation to tenants; and there is a small proportion of ordinary freehold land in the hands of private owners.

UNITED STATES.—All vestiges of British feudalism were swept away in the United States soon after the acquisition of independence. Occupying ownership is the rule in that country, although tenancy has increased considerably in prevalence during the last twenty years, in many cases being based on the produce-sharing system. Under the Homestead Law any man, native or immigrant, may obtain a free grant of 160 ac. of national land. This is the subject of strong complaint among some of the farmers and their representatives in the Press, the partial ruin of farming in the Eastern States being attributed to the unequal competition of land given to the occupiers and hardly taxed at all, with land bought by the owners and taxed comparatively heavily. The transfer of land is effected simply, and at only a trifling expense.

CANADA.—In Canada, land tenure is similar to that of the United States, except that tenancy is much more uncommon, if it exists to any appreciable extent. Free grants of uncleared Government land 100 to 200 ac. in extent are made in the provinces of New Brunswick, Quebec, and Ontario, and 160 ac. in area in Manitoba, Alberta, Saskatchewan, Yukon, and parts of British Columbia. As in the United States, again, immense tracts of land have been granted to railway companies in order to obtain the construction of railroads, and the monopoly of large proportions of land near the lines by great corporations is one of the chief disadvantages of which settlers complain.

AUSTRALIA.—The most varied systems of land tenure are to be found in our Australasian colonies, in all of which the desire to tempt settlers, and thus to develop the resources of the countries, has led to a lavish alienation of national land. Between the foundation of the colonies in 1787 and the year 1859 over 7,000,000 ac. in that island continent and Tasmania had been alienated, though free grants of land had been abolished in 1831. Sales at a minimum of 5s. per acre up to 4000 ac. to one person or 5000 ac. to a family had been allowed since 1825, and many large pastoral estates were thus founded. From the fact that variations in the numerous legislative enactments in relation to land purchase or occupancy took place in the several colonies, Australian land tenure has become a highly complicated subject. The 'chief methods of land tenure' under Acts at present in force in New South Wales, as given in the first official Year Book of the Commonwealth of Australia, published in 1908, are no fewer than fourteen in number, and a new Act modifying one or more of the earlier ones was passed in December of that year. These 'chief methods' are named as follows: Residential conditional purchase, non-residential conditional purchase, conditional lease, homestead selection, conditional purchase lease, settlement lease, settlement purchase, closer settlement annual lease, improvement lease, annual lease, residential lease, special lease, snow lease, and improvement purchase. Any person not under sixteen years of age may obtain, on residential conditional purchase, land ranging in area from 40 to 640 ac. in the Eastern Division, from 40 to 2560 ac. in the Central Division, or up to 640 ac. in the Western Division, on paying a deposit of 10 per cent on the value of the land at £1 per acre, or the value set by appraisement if he pleases to have it valued. At the end of three years, and annually afterwards, he must pay 5 per cent of the value of the land, including interest at 2½ per cent, until the balance with

interest is paid off. The conditions relate to fencing, improvement, and other details. In the case of non-residential conditional purchase, the maximum area is 320 ac., while the price, deposit, and annual instalments are double those of residential purchase, and the conditions are more onerous. A conditional lease is granted only to a person who has acquired land under residential conditional-purchase conditions. The rent is only a few pence per acre, and the term of the lease is forty years, during which the lessee may convert the whole or part of the land into an additional conditional purchase. Good agricultural land not exceeding 1280 ac., or lots near towns, each large enough for a family, may be obtained under homestead selection for residence, which must be continuous for the first five years, after which a grant is made, and at least seven months' residence is required in each later year. The annual rent is 1¼ per cent of the capital value of the land for the first six years, and 2½ per cent afterwards, the value being subject to revaluation every ten years. The area selected may be increased if found insufficient for the support of a family. Tenant-right in improvements is secured, and fixity of tenure may be obtained. This tenure is somewhat similar to that of land nationalization. A conditional purchase lease is a tenure under which a settler, on payment of a small deposit, can obtain land at a moderate rent and on easy conditions on lease for forty years, with the right of converting it into a conditional purchase at any time, and so ultimately into a freehold. Such a lease can be obtained only within areas specially set apart by the Government. Settlement leases have been provided for persons who require large areas of land for agricultural or grazing purposes. The conditions are somewhat similar to those of homestead selection leases. For the purpose of the closer settlement purchase system the Government may resume possession of alienated land on terms of agreement or compulsory purchase, to transfer to persons who desire to make homes on the soil under conditions of payment which confer the freehold in thirty-eight years. A closer settlement annual lease is to be obtained on not over 320 ac., subject to such conditions as the Governor may prescribe. Such a lease expires at the end of each year, but may be renewed on the payment of a year's rent in advance. An improvement lease has terms suitable for land which is of but little value until it has been improved under tenant-right conditions. At the end of the term the lessee may convert it, if not over 640 ac., into a homestead selection. An annual lease is similar to a closer settlement annual lease, except that it may relate to a larger area of land. A residential lease is arranged only for proclaimed gold or other mineral fields, the area leased being not over 20 ac. Special leases are issued chiefly to meet requirements for industrial or business purposes. Snow leases relate to land usually covered with snow for a portion of the year. Improvement purchases are only for goldfields, and are limited to ¼ ac. of land in a town or village, or 2 ac. outside. The principal object of the Act passed in December, 1908, is that of facilitating the conversion of residential leases of various kinds into freeholds. The conditions of some of the methods of land tenure noticed above are too voluminous to be given in full detail. The various forms of land tenure have been devised at different times to meet varying requirements; but some of the leases are so similar in terms that the great complication of conditions may well be considered more puzzling than advantageous. Up to the end of June, 1906, out of a total area of 198,638,080 ac., 49,970,335 ac. had been alienated or were in process of alienation, and 124,027,009 ac. were held under leases, leaving 24,430,714 ac. unoccupied. Another official table gives the numbers of holdings of various sizes, covering 48,728,542 ac. of land, absolutely alienated at the date named above. The number of holdings was 77,136, and that of holdings from 1 ac. to 50 ac. was 32,413; but the area of them was only 488,622 ac. More than half the holdings were not over 100 ac., and two-thirds were not over 200 ac.; but the total area up to this last limit was only 2,734,866 ac. No fewer than 110 holdings were over 50,000 ac. each. There is no corresponding account of the distribution of the much larger area of leased land.

Although some of the forms of disposing of land in Victoria are similar to those in use in New South Wales, it is curious that not one of the principal forms has the same name in the two States. In Victoria they are pastoral leases, grazing-area leases, perpetual leases, leases of auriferous lands, leases of swamp or reclaimed land, leases and licences for other than pastoral and agricultural purposes, agricultural allotments, grazing allotments, and sales by auction. Land may also be acquired for village communities, homestead associations, labour colonies, closer settlement, and small improved holdings. In connection with most of the leases, facilities for obtaining the freehold are provided But under the perpetual lease a settler may hold a larger area of land on easier terms. The annual rent is only 3*d.* in the £ on the value of the land, which is fixed at £1, 15*s.*, 10*s.*, or 5*s.* per acre according to quality and position. The rent is subject to revision every ten years, but must not be put over 3*d.* in the £ on the value of the land apart from improvements. This form of lease would reserve the perpetual ownership of the land to the State if it were not for the fact that the leaseholder, under certain conditions, may surrender his lease and obtain an agricultural licence for the land, which then becomes his freehold. The total area of Victoria is 56,245,760 ac., and up to the end of 1906 no less than 22,964,929 ac had been absolutely alienated from State ownership, and 3,871,114 ac. were in process of alienation. Only 29,267 ac. were held under perpetual leases. Altogether, including leases, State and other public reserves, town lands and roads, all but 12,758,040 ac. had been disposed of.

In Queensland, out of 429,120,000 ac., 18,322,643 ac. had been sold or were in process of being sold by the middle of 1906, while 247,059,213

ac. were held under leases and licences, leaving 163,728,144 ac. unoccupied. Grazing runs occupied over 182,000,000 ac., and grazing farms and homesteads nearly 25,000,000 ac.

In South Australia the principal forms of land tenure are those under pastoral, perpetual, and other leases, village settlements, homestead blocks, closer settlements, licences, and sales by auction. Out of an area of 243,244,800 ac., apart from the Northern territory, 8,946,958 ac. had been sold or granted for public purposes, or were in process of absolute alienation, up to the end of 1906, and 94,969,554 ac. were held under leases. In the Northern territory, covering 335,116,800 ac., only 473,280 ac. had been alienated, while 110,199,367 ac. were held under leases, chiefly pastoral.

In addition to various forms of purchase and leasing provided for in Western Australia, free homestead farms and working-men's blocks may be obtained. Any head of a family or male not under sixteen years of age who is not already in possession of more than 100 ac. in the State, may select an area of 10 to 160 ac. of land as a homestead farm in specified districts, free of any payment other than a fee of 20*s.* on application, and another of 30*s.* on the grant being made. The building of a house and other conditions are obligatory. Any person not holding land in the State may obtain a workman's block of land of half an acre in a town or goldfield, or 5 ac. elsewhere. The price is not less than £1 per acre, payable during a lease of ten years by half-yearly instalments, and there is a lease fee of 10*s.* At the expiration of the lease, or at the end of five years, if the full balance of the price be paid, and the conditions as to improvements have been fulfilled, the holder acquires the fee simple. Out of 624,588,800 ac. of land in Western Australia, 12,575,902 ac. had been or were in process of alienation up to the middle of 1906, and 152,527,740 ac. were held under leases and licences, leaving 459,455,158 ac. unoccupied.

TASMANIA.—In Tasmania, in addition to sales by auction or free selection, and pastoral and other leases, there are arrangements for homestead selection on easy terms, and closer settlement. Out of a total area of 16,777,600 ac. in the island, 5,479,538 ac. had been or were in process of being alienated up to the middle of 1906, and 1,344,320 ac. were held under leases and licences, leaving 9,953,742 ac. unoccupied.

NEW ZEALAND.—Until the Land Laws Amendment Act of 1907 came into operation, the three principal tenures of land in New Zealand were as follows:—

1. Sale of the freehold, one-fifth of the purchase money being paid at once, and the remainder within thirty days, the final title being withheld until certain improvements have been made.

2. Lease for twenty-five years at a rent of 5 per cent on the value of the land, with a right to purchase at the original upset price at any time after the first ten years, or to convert the lease into a perpetual one, the third system.

3. Lease in perpetuity, so named, for 999 years, at a rent of 4 per cent on the value of the land, not subject to any increase or recurring valuations. Under this system there is fixity of tenure practically equal to that of freehold, with equal powers of sale, subletting, mortgaging, and bequest. At the same time improvements are secured to the tenant by the State, in the event of his being obliged from any cause to forfeit or surrender his lease. A very large proportion of Crown land has been disposed of under this system. The limit of area fixed by the Land Act of 1892 for any selection of Crown land, whether on lease or on purchase, was 640 ac. of first-class, or 2000 ac. of second-class land. A further limit of 5000 ac. for third-class land was added in the Act of 1907.

The Act of 1907 provided that no Crown land should be disposed of in future by way of a perpetual lease, but that any land which, but for this prohibition, might have been so disposed of, may be let on a renewable lease of sixty-six years, with a perpetual right of renewal, the rent being 4 per cent upon the capital value of the land, subject to revaluation at the end of every lease, apart from permanent improvements made by a lessee or purchased by him from a predecessor. The rent is never to exceed 4 per cent upon the capital value of the land apart from improvements. The Crown is not responsible for the payment of the lessee for improvements at the end of a lease, if it is not renewed. A renewable lease does not confer any right to extract or remove minerals from the land unless a licence is obtained, on terms to be fixed by the Minister of Lands and the Land Commissioners; but a lessee may use minerals on the holding for any agricultural, leasehold, roadmaking, or building purpose. Provision is made for making records of improvements. The lessee of a renewable lease may bequeath it, but may not assign or otherwise dispose of his interest in the land, except by way of mortgage, until he has resided at least two years on the land, and then only with the permission of the Minister and Commissioners of Lands. So far the provisions relate to rural land, and there are separate arrangements for town, suburban, and village lands not within village settlements. A lease for such lands may, at the discretion of the Land Commissioners, be an ordinary one for not more than ten years, or a renewable lease on the same terms and conditions as one of rural land, except that the term is thirty-three instead of sixty-six years, and the revaluation accordingly, and that the payment for improvements is to be due from the incoming tenant instead of from the Crown.

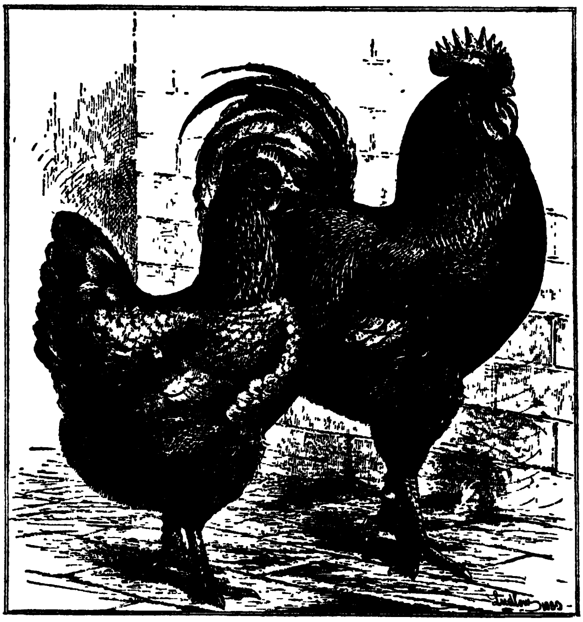
Any lessee under a perpetual lease may at any time after the passing of the Act of 1907 purchase the fee simple of the leased land, or convert his lease into a renewable lease. The latter, however, has proved very unpopular among settlers, who object to be deprived of the right to acquire the fee simple of leased land. The Minister of Lands lost his seat at the general election of December, 1908, and his rejection has been attributed to the unpopularity of the land policy of himself and his colleagues in the Government.

The village-settlement system of New Zealand provides for villages of 1 ac. sections or small farms of 100 ac. Other arrangements are for settlement by small-farm associations, and for what is called the improved-farm settlement system; but, as both were on the basis of perpetual leases, the Act of 1907 has modified the tenure so far as the future is concerned. Yet other special arrangements are for the settlement of bush and swamp lands. At the end of March, 1908, according to the Report of the Department of Lands, only 7,488,628 ac., apart from Native Lands, remained to be disposed of.

INDIA.—The land systems of India are far too elaborate to be fully described in this article. They vary in the several provinces and in different parts of a province. But throughout British India the rent, or a Revenue tax more or less nearly equivalent to a customary rent, is collected by the State from the cultivators individually, from village communities acting for individuals (who do not, however, cultivate land in common), or from zemindars, or similar authorities to whom British rule has given practically the position of landlords, though with limited powers. [W. E. B.]

Land Valuator. See art. VALUATOR AND VALUATION.

Langshan Fowl.—From all appearances the Langshan would seem to be a very old breed, and its prepotency when crossed with other races is very striking indeed. It comes to us from a part of China on the Yangtze River, and was first imported into Britain in 1872, when it was regarded as a variety of the Cochin family. The importation of this fowl led to very great controversy, which need not concern us here, and it has been unfortunate in its friends, for reasons stated below. The Langshan is a tall, somewhat leggy bird, the head and tail being almost equal in height. It is pure-black in plumage, with a great brilliance of sheen, and there is a slight coating of feathers down the outer side of the legs and feet, which are generally black in colour. The comb is single and rather small in size. So far as flesh qualities are concerned these are fairly good, the skin being very light grey. The birds are heavy in body, though fairly light in bone, males weighing from 8 to 10 lb. The special point which gave the Langshan a measure of popularity was their excellence as winter layers, the eggs, whilst somewhat small in size, being beautifully tinted in shell; in fact, in that respect these eggs are about the best-looking that we have. Unfortunately, however, the Langshan has been spoiled. Some years after its introduction the Black Orpington was evolved, which owed much to Langshan blood; and with a view of giving a greater distinction to the two races, exhibitors went in for a great elongation of the leg in the Langshan, with the result that what are called modern Langshans have been entirely ruined for practical purposes. These are very long in leg, and as a consequence much heavier in bone, whilst they have lost a great deal of the fineness of flesh and skin; the quantity of flesh upon the body has also been reduced. More recently the older type of Langshan has been brought to the fore, and for practical purposes it is distinctly to be preferred. Since the first introduction of the Black Langshan, Whites and Blues have also been developed, but the Black is the original type. [E. B.]



Langshan Fowls

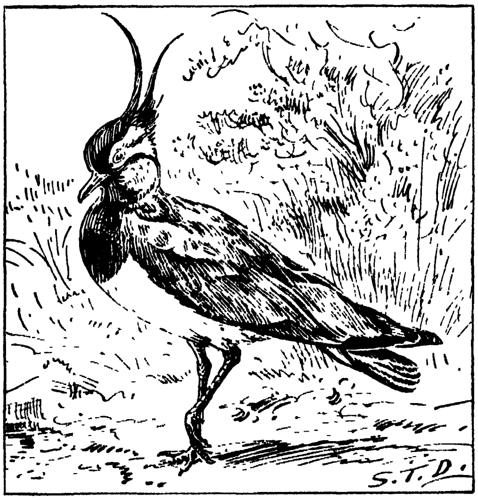
Lapageria, a monotypic genus of Liliaceæ; *L. rosea*, a native of Chile, which has large, waxy, bell-shaped, rosy-crimson flowers, being one of the best of all greenhouse climbers, while the white-flowered variety is equally and deservedly popular. These plants are particularly well adapted for training over a considerable expanse, such as along wires in the centre of a span-roofed greenhouse, or in a greenhouse corridor. In the warmest parts of the country they will succeed out-of-doors on a wall. They require a cool temperature and shade in summer, with good drainage, and frequent sponging to keep the leaves free from scale, &c. They are usually propagated by layers, and prefer a sandy, peaty soil. [W. W.]

Lapsana communis (Nipplewort) is a common annual weed of hedges and fields belonging to the nat. ord. Compositæ, and to that division of the order which has milky juice (Ligulifloral Compositæ). The heads are small and yellow. See NIPPLEWORT.

[A. N. M'A.]

Lapwing.—The Lapwing, Peewit, or Green Plover (*Vanellus vulgaris*) is the commonest

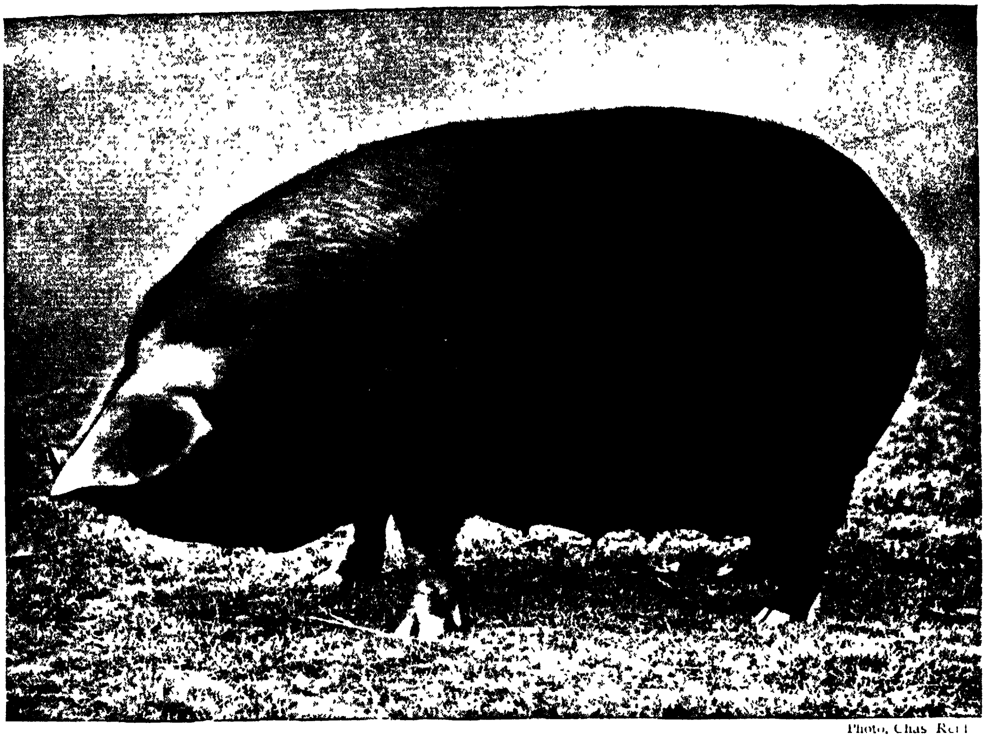
British representative of the great order Limicolæ, or wading birds. It is widely distributed throughout Great Britain, and resident all the year round, though in severe weather a partial migration southwards takes place. It derives its name 'lapwing' from its manner of flight—a slow flapping of the wings. The name Peewit, as also the French name *Dix-huit*, is taken from its well-known cry. The favourite haunts of the Lapwing are marshy ground near lakes and rivers, wild moorlands, or unenclosed country. Its nest is scarcely more than a depression in the ground, in which normally four eggs are laid, usually during the month of April. The food consists of worms, slugs, and insects; and the bird is in consequence very beneficial to agriculture. In autumn they collect into large



Lapwing

flocks, and at this season of the year their numbers are greatly augmented by the immense packs which arrive from the Continent. When the nest is approached, the male dashes about with frantic cries; and in both sexes various ruses are employed to allure the intruder away from the nest. The empty nests often found are 'false nests', which are made by the cock bird in rolling and turning about as he shows himself off before the female. The Lapwing has a long erectile crest; the upper parts are greenish; and the contrast of black and white in the plumage is very conspicuous during flight. [H. S. R. E.]

Larch (Larix) is a genus of the Pinaceæ family (syn. Coniferæ) of the great Gymnospermæ class of plants, characterized by possessing ovules and seeds not enclosed in an ovary. In this family, which comprises Araucaria, pines, cedar, larch, firs (Silver, Douglas, and Spruce), and other genera, the fruit is a cone, and the leaves are narrow, often needle-like, and usually persistent. Among these, Larch is most closely related to the cedar genus. Each has double cone scales with two seeds on each, and narrow, spirally arranged leaves, and some of the needles in tufts consisting of many needles; but while the cedars are evergreen, and have stiff needles, and erect cones with scales falling off separately, the larches are deciduous, and have soft pale needles, and cones falling off whole. The larches are easily distinguished from other trees by their dwarf shoots (conspicuous even in winter) bearing tufts of numerous light-green, deciduous, flat needles; by the main branches not being regularly disposed in false whorls, although the general habit of growth is distinctly that of a conifer; and by the branchlets hanging down and bearing purple female flowers and small woody cones which point upwards and ripen within six months after the flowering. Several species of Larch are known, all of which are indigenous to northern latitudes. All of them are deciduous trees, and most of them attain large dimensions. They include the Common or European Larch (*L. europæa*) indigenous to the mountains of Central Europe and especially frequent on the Alps, the Western Larch (*L. occidentalis*) found in the Rocky Mountains of America, the Japanese Larch (*L. leptolepis*), the Kurile Larch (*L. curilensis*), and the Siberian Larch (*L. sibirica*), which have all been introduced into Britain. The European, American, and Japanese species are all three now being grown in British woodlands. The first two have shoots with ash-grey bark, but the Western American species is the more rapid in growth, and has thicker and more rigid leaves, and larger cones, while the shoots of the Japanese Larch are reddish-brown, and the foliage in autumn is of a much paler yellow than that of the European species. Although rapid in growth, Larch yields the toughest, strongest, and most durable coniferous timber grown as woodland crops, and furnishes fine timber having a dark-red heartwood. But even young wood is hard, tough, and durable, hence suitable for fencing, &c.; and though in most parts of Britain now very liable to a serious canker disease (caused by the fungus *Dasyscypha calycina*, syn. *Peziza Willkommii*), it is often still the most profitable kind of tree to plant on hilly land having good natural drainage. The timber of both the European and the American species is superior to that of the Japanese; but the latter (introduced in 1861) has recently been largely planted owing to its rapid growth at first, and to its being, as yet, comparatively immune from canker. The American Larch, only recently introduced, grows as rapidly at first as the Japanese, and produces as fine timber as the European; but unfortunately its seed is very scarce and expensive, being difficult to collect, as the cones open and shed their seeds within about a fortnight of ripening. With cheap seed and young plants this American species would probably exceed in economic value the Common Larch, itself one of the most valuable timber trees introduced into Britain. Its introduction into England took place in 1629, into the Scottish lowlands in 1727 (Sir James Nasmyth, Dawyck), and into the Highlands in 1738 (Mr. Menzies of Glenlyon and Meggany, and the Duke of Athole); but it was mainly through the Duke of Athole's recognition of



Photo, Chas. Reid.

LARGE BLACK SOW—"TREVEGLOS HOPEFUL 2ND"

WINNER OF FIRST PRIZE AND CHALLENGE CUP, R.A.S.E. SHOW, 1907

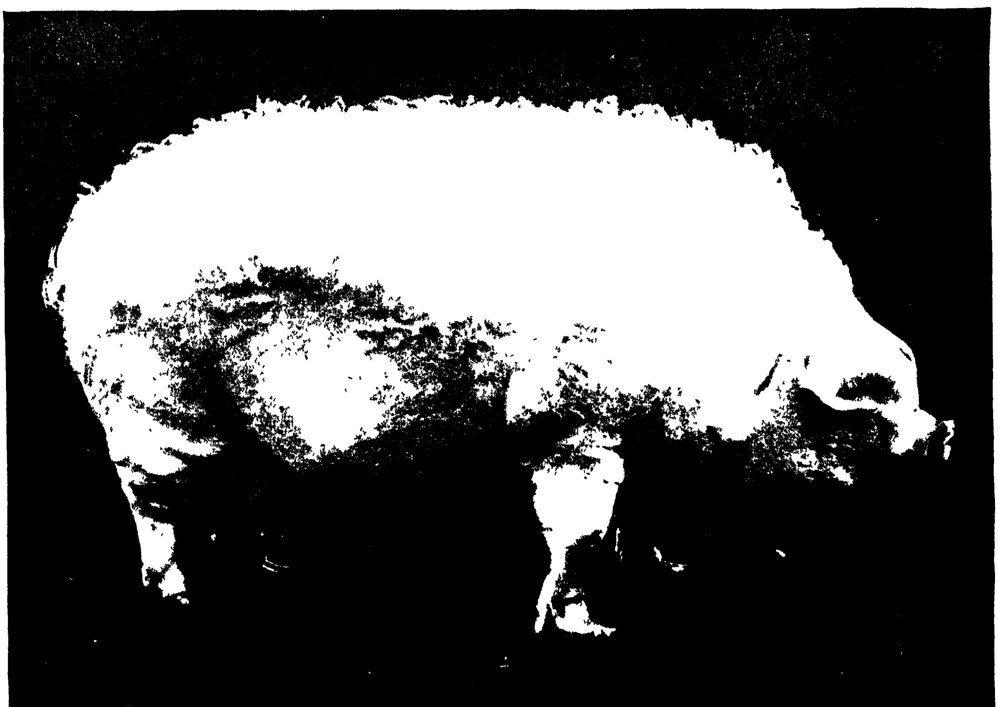


Photo Chas. Reid.

LINCOLN CURLY-COATED SOW "MIDVILLE A1"

its fine qualities as timber that its cultivation took place on a large scale in Scotland. Six of these first larches still grow at Dawyck, one at Keir, one at Monzie, and one at Dunkeld. The tree attains in Britain a height of up to and sometimes over 100 ft., and a girth of from 10 to 12 ft. As a forest tree its best growth is when mixed among Beech, but it also thrives well when interplanted among old coppices, and its wood finds a ready sale in most places. It is one of the most light-demanding of our trees, and can only grow well when its crown is fully exposed to light and air. Its root system is deep-reaching, so that it requires a light or permeable soil and subsoil, which should both have a good natural drainage. It does well on fresh lime and light loam, but not on land that is either dry, wet, or stiff; and it usually thrives best on a northern slope. There is good grazing in old Larch woods, and this was one of the reasons which induced the Duke of Athole to make large plantations about the middle of the 18th century. In the Alps it grows single or in small groups among other conifers; and it is probably mainly due to having been largely planted pure in Britain, and often on a soil and in a situation naturally unsuited for it, that the cankerous fungus disease was able to become so damaging a parasite. Larch can easily be raised from seed, sown broadcast at the rate of about 1¼ lb. per 100 sq. ft. of seedbed, and lightly covered with fine earth. When wanted for notching two-year-old seedlings are used; but otherwise it can be set out as yearling or as two-year-old seedlings in the nursery lines, and planted out after standing there for one or two years. Although a hardy species, it sometimes gets badly damaged by late frosts in the early summer wherever these are frequent (much damage was thus done in Argyllshire during June and July, 1908). In the warmer parts of Britain Larch is apt to be attacked by *Chermes laricis* and by *Coleophora laricella*; and wherever this is the case, there is always great danger of the canker disease thus being enabled to effect an entrance. [J. N.]

Larch Disease.—Of all diseases attacking growing timber in Britain, canker or blister of Larch is probably the most destructive. A cankered tree is generally recognized by an outflow of resin from flattened or depressed places in the bark; when the tree is cut through at this place, the outer year-rings will be found not to form a complete ring. Round a canker the bark is frequently raised into a ridge or 'blister', and in each depression the remains of a dead twig may generally be found. Canker-spots were artificially produced by Robert Hartig, who infected wounds in healthy trees with the spores of a fungus common on cankered larches. This fungus, *Peziza willkommii* (sometimes called *Dasyscypha calycina*), belongs to the sub-order Discomycetes of the order Ascomycetes (see art. FUNGI). The ascus-cups are small (rarely exceeding ⅛ in. in diameter), but their bright orange-red colour when open renders them conspicuous on the bark of cankered spots and dead twigs. Germinating spores bring about infection through any small wounds in the bark, and the fungus-filaments grow at the expense of the young wood and bark. Each year the gap in the year-ring becomes wider, till finally sap is no longer conducted upwards, and the tree dies. A vigorous tree may, however, isolate the fungus, and with increasing age become to outward appearances a healthy tree. Wounds are said to be essential for infection, hence Larch canker is frequently preceded by attacks of the Larch Aphis and other insects (see special articles), or by frost damage. The disease is almost entirely confined to European Larch, but cases are known of its occurrence on Japanese Larch and other conifers

Treatment.—No direct method of extermination has been found. The best preventives—suitable soil, situation, and cultural treatment—are discussed in the art. LARCH.

WOOD ROT.—When growing with Scots Pine and other conifers, the Larch may be attacked by Pine Red-rot and the Honey Mushroom (see PINE—PARASITIC FUNGI).

NEEDLE-CAST.—Several fungi accompany premature loss of leaves. One of the most frequent is a rust formed by the aecidiospores of a fungus (*Melampsora*) which produces its uredospores and teleutospores on Birch leaves.

Seedlings in the nursery are frequently killed off in large numbers by the Tree Seedling Fungus (see BEECH—PARASITIC FUNGI). [W. G. S.]

Lard is fat from the pig. To obtain lard, the tissues containing the fat are cut into small pieces, heated in an open vessel over the fire, and constantly stirred. The heating causes the fat-cells to burst, and the liquid fat obtained can be readily separated while hot from any solids. Lard is a mixture of fats, the principal being palmatin, olein, and stearin. It is solid at the ordinary temperature, but not so hard as tallow. When pure it is white, almost tasteless, and odourless. It melts between 30 and 45 C., forming a clear liquid. Occasionally it turns rancid by the action of ferments, which are encouraged by storage under unsuitable conditions. By the action of pressure on lard in the cold, a limpid, almost colourless oil, called lard oil, can be extracted. Olein is the principal component of this oil, and it is used as a lubricant and for illuminating purposes, also as an adulterant. Lard has a specific gravity about ·932. It often contains a good deal of water as an adulterant. Cotton-seed oil, beef fat, stearin, and cocoanut oil are occasionally found mixed with lard. Lard is a valuable food. Its principal uses are for culinary purposes, for making soap, butterine, ointments, &c. Compound lard is a mixture of cocoanut oil and stearin.

[R. A. B.]

Larder Beetle, a pest in the kitchen and larder. See DERMESTES.

Large Black Pigs have been considerably improved of late years both as regards early maturity and form, and it is probable that this advance on utility lines would have been more pronounced had there not existed between the two sections of breeders of Large Blacks so great a difference of opinion as to the best type of pig. Black pigs of a large size have been bred for many years in Essex and adjoining counties, as well as in Cornwall and Devon,

but the pigs in these two districts were of dissimilar types: those bred in the east were lighter in head and bone, longer and flatter in side, and had better-shaped hams; whilst the west-country pigs had shorter and heavier heads, stronger bone, thicker shoulders, shorter and deeper sides, and rounder hams. Both types of these black pigs were prolific, hardy, and quick growers when young, and the sows good sucklers. It would appear that when a society for the registration of the pedigrees of Large Black pigs was established, sufficient attention was not given to those anticipated difficulties which arose when the endeavour was made to mould the two types of pigs into one type, and to evolve a pig which should entirely meet the views of two sets of breeders whose ideas had been founded on local wants and requirements of a totally different character, especially as to the market demand for fat pigs. Another point which did not receive sufficient attention was the scale of points which was drawn up and adopted by the breed society. A higher value is said to have been placed on certain points which are more pronounced in the west-country pigs than in those bred in the eastern counties; and what appears to be of still greater importance, it is asserted that these points are really of far less value than some others which are not so highly esteemed. A study of this scale of points shows that from the practical point of view too great consideration has been given to the head generally, the ears and jowl, and the shoulders — the least valuable commercial parts of the pig. For several reasons this may be a mistake, particularly on account of the fact that the Large Black of the western counties is noted for its heavy jowls, short snout, long pendent ears, and heavy shoulders, parts of the carcass of the pig which are of comparatively small value. The question is a moot one whether or not it would have been wiser to have placed a much higher value on those parts of the body of the pig which are in much greater demand and therefore realize better prices, but which may not be so marked a feature of the formation of the Large Black pig. The necessity for some serious consideration of these points appears to have forced itself upon the breeders of this variety of pig, which undoubtedly has a future of great usefulness, provided that breeders adopt the motto 'Utility first, then fancy'. Very large numbers of sows of the breed are kept in Essex and Suffolk and crossed with Large White boars, which impart a greater length of body, a better-shaped ham, lighter fore quarters, and a white skin. The fattened cross pigs also yield a superior bacon. There may not be so great an incentive to breeders to improve the form of the Cornish-bred pigs, since the local demand is for pork of a somewhat different class and substance. The miners are not quite so choice in their food as the residents in the West End of London.

[S. S.]

Large Death-watch Beetle, a beetle which, both in its larval and adult stages, is destructive to timber and woodwork. See ANOBIUM DOMESTICUM.

Large Hover Fly, a useful insect which aids in destroying large numbers of plantlice. See CATABOMBA.

Large White Pigs are declared by some writers to have been brought into prominence, if not originated, by some two or three exhibitors of pigs about the middle of the last century; but the correctness of this surmise is at least doubtful, since engravings of a hundred years ago are extant which exhibit very large pigs with some of the points of the present-day Large White, but with a considerable portion of the skin of a dark-blue colour. Some admirers of the breed even declare that the natural colour of the English pig was white, and in support of this contention point to the fact that a pure-bred white boar will beget white pigs from sows of any colour with which it may be mated. Although this fact may not quite prove that white was the original colour of the native pig, yet the inference that it has been bred to colour for a great length of time appears justifiable. It will be readily understood that an animal which so quickly reproduces its species is liable to great changes in its conformation and character as the keepers of pigs are influenced by fancy, fashion, or market demands. The Large White pig has, to the writer's knowledge, undergone very many and considerable changes during the last sixty years. In the 'fifties, when the pig classes at the Royal Agricultural Society's shows were subdivided into those for white and for coloured pigs, pigs of the former colour were of two more or less distinct types—the short-snouted, fat-backed pig, which was subsequently termed the Small White, and the much larger, heavy-fleshed, and strong-boned pig, to which the name of Large Yorkshire was given. There was little systematic breeding of pigs at that period. The most usual plan was to mate the extremely large and gaunt sow with a compact and neat boar. The resultant offspring would naturally be of varying types. Some would mature early and pass into the Small White section at the shows; while the larger and coarser pigs would at times commence their show career amongst the small or medium-sized pigs, and when completely grown would emerge as Large Whites. This peculiar system was in force even as late as the Birmingham 'Royal' some thirty years since, when importers of pigs from the United States called attention to the extraordinary manner in which Royal Show prize-winning pigs of the various breeds were evolved, and to the fact that many of the chief winners were entered as 'age and breeder unknown'. The subsequent formation of a society for the registration of the pedigreed pigs completely put an end to these peculiarities, which were the results of that craving for notoriety which had seized upon a certain few rich men or upon their agents. In the middle of the last century, and before the use of ice or the cold-air chambers in the curing of bacon became general, there was some excuse for keeping pigs for slaughter until they were some eighteen months or two years old, and for making them extremely fat, since, in order that the bacon and hams could be kept through the summer, the

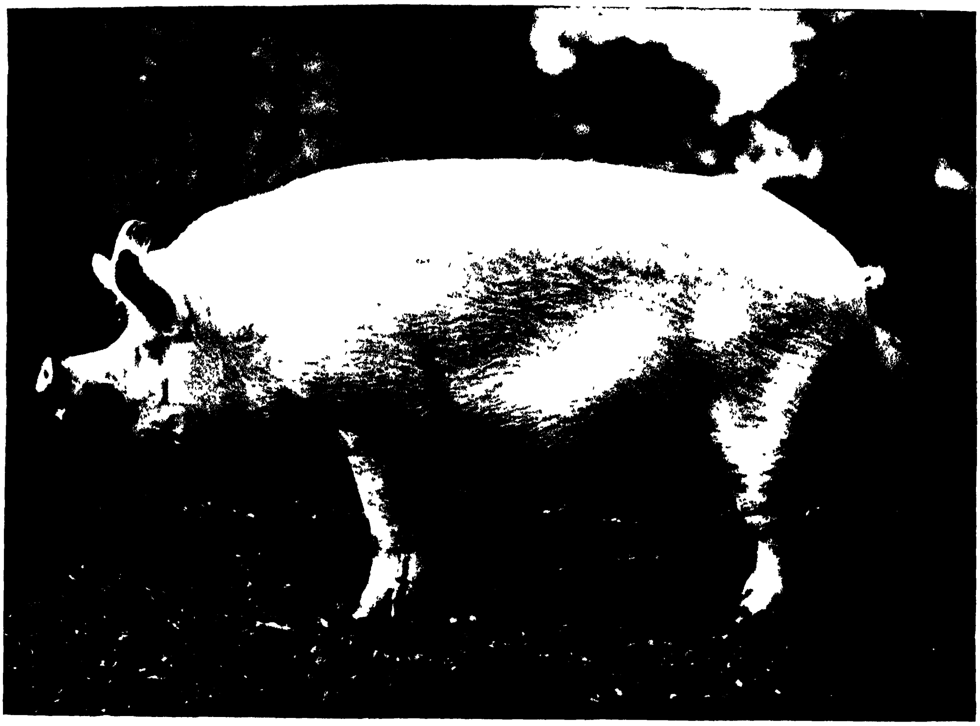
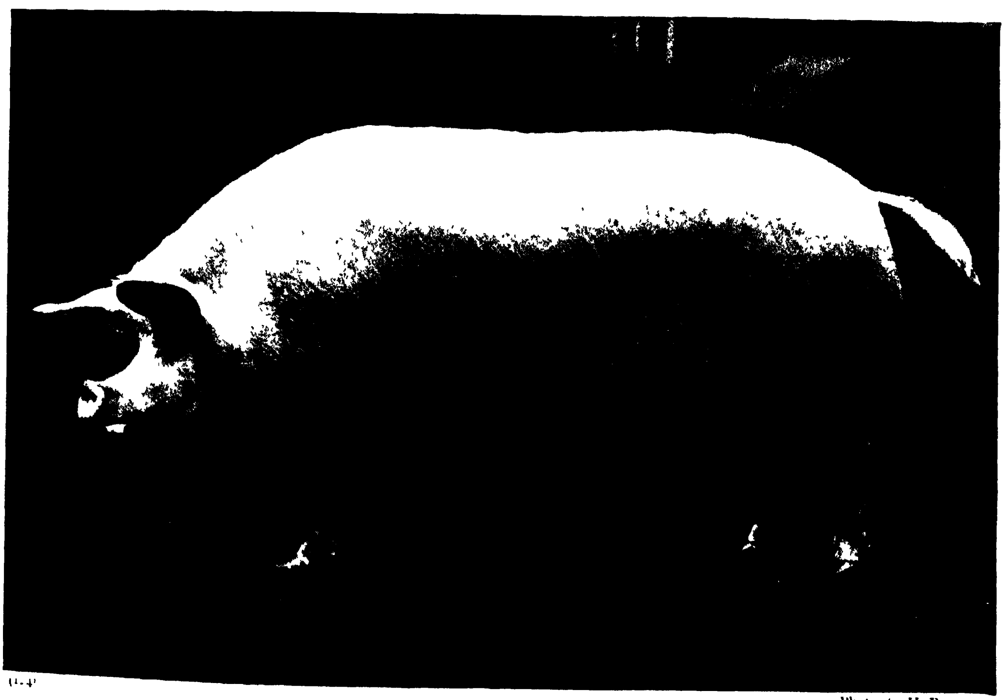


Photo. G. H. Parsons

LARGE WHITE BOAR—"SAMPSON OF WORSLEY"

WINNER OF FIRST PRIZE, R.A.S.E. SHOW, 1909



(I. 4)

Photo. G. H. Parsons

LARGE WHITE SOW—"BOTTESFORD MONCHINGTON QUEEN"

WINNER OF FIRST PRIZES, R.A.S.E. SHOWS, 1908 AND 1909

salting process had to be continued until the lean meat was thoroughly sodden with salt, and thus rendered in a condition most unappetizing save when associated with a considerable proportion of fat. As soon as the mild-curing system became general, the extremely big and fat pigs were not needed. The requirements then arose for a long-sided and flesh-carrying pig which would mature at an early age and would furnish a side of bacon weighing from 50 to 60 lb. The old-fashioned type of Large Yorkshire was short in the head, very heavy in jowl, shoulders, and bone, long in the back, drooping in the quarters, and slow in maturing. Shortly after that period the black-and-white spotted pig, which has in its composition the blood of the white, the black, and the red or russet-coloured pig, became the favourite of the bacon-curer, since these pigs were of lighter weights, were finer in the bone and skin, and better developed in the hind quarters. But fashion once more made sad havoc with the commercial points of the pig when our American cousins, having collected enormous sums from the accumulated fertility of the virgin soil, from the metalliferous deposits, from the virgin forests, and even from the conversion of maize into beef and pork, turned their attention to the breeding and rearing of improved stock, or at least to the evolution of a new type. This hobby lent itself to fancy; and one form of this weakness, so far as it related to pigs, demanded that the improved pig should have an extremely short head, an unnaturally heavy jowl and crest, and that its shoulders should be very wide. As the question of money did not enter into the bargaining for these monstrosities, the breeders of English pigs endeavoured to secure a portion of these dollars which appeared to be almost inexhaustible in extent; and succeeded so well, that the pigs, ornamental as they might be, were comparatively useless for conversion into bacon which would meet the current demand and realize a profit to the curer and the purveyor. The principal firms of English bacon-curers, whose factories were at Calne, in Wiltshire, proceeded to demonstrate by the aid of printed matter, by photographs, and by every other possible means, the great losses which were being sustained by everyone in this country, through the folly of pig-breeders following the silly fashion of the American fancier, and neglecting the increasing demand from all parts for the highest quality of bacon. One or two well-known breeders of Large White pigs appear to have first grasped the situation. They paid particular attention to the length of side, fullness of ham, leanness of flesh, lightness of fore quarters, bone, and offal of their pigs, as well as to their early maturity; and this example was gradually followed, until the Large White pig became the most popular pig wherever the manufacture of bacon on an extensive scale was practised. And this popularity of certain herds of the Large White breed of pig still continues, as hundreds of breeding pigs are annually exported. This strong commercial influence was not, however, sufficiently powerful to completely overcome those fanciful practices of the moneyed hobbyist—who could afford to purchase a sufficient number of pigs for exhibition purposes—or to influence that section of the dealing and breeding fraternity which is always in evidence where money, want of practical knowledge, and desire for notoriety are in combination. These dealers or middlemen manage to secure positions as judges at the chief shows, frequently by the aid of those connected with animals purchased of them for exhibition; and the decisions of these judges are certain to be affected by their tastes or fancies as shown when selecting or buying the pigs in the first instances, the result being, that a standard of merit is set up which does not reflect the matured opinions of practical men, who are best qualified to determine the form, character, and quality of the pig most profitable for producer, manufacturer, and consumer. The Large White has gone through many changes of form and size. As previously noted, we have had the heavy-forequartered, short-snouted type; the long-snouted, hard-skinned, heavy-boned, and slow-maturing pig of immense size; the more compact pig, with fine quality of bone, skin, and meat, lengthy in its side, thick in its flank, and of early maturity; and at the present time mere size is one of the points apparently most sought after, or as one of the fanciers remarked, 'You must have great size in a Large White pig'. It would have been simply so much time wasted to have attempted to show this fancier that it is not the fancy points but the useful and commercial points of a pig which will determine the value and even the continuance of any variety of pig or other domesticated animal.

Breeders of Large White pigs claim that their favourites are very quick growers and feeders, good graziers of grass, clovers, &c., good rustlers in woods and forests, and that the sows are prolific, good milkers, and very tractable. There is no doubt that bacon-curers in all parts of the world are most favourably disposed towards fat pigs of this breed, or which are begotten by Large White boars; whilst pig-feeders have proved that it is possible to produce fat pigs, suitable for conversion into bacon of the highest value, as quickly and at as little cost by the aid of Large White pigs as by those of any other pure breed or cross. [s. s.]

Larix, the botanical designation of the Larch.

Lark.—Of the three species of lark commonly found in Great Britain, the Skylark (*Alauda arvensis*) is by far the best known. Although local in the north of Scotland, it occurs in every part of the British Isles; and everywhere in the springtime it is recognized by its well-known song, which it pours forth as it rises high in the air, till almost lost to sight. Of the other two species, the Woodlark (*Alauda arborea*) is locally distributed in England and Wales, being commonest in the south, and very rarely if ever reaching Scotland. The Shorelark (*Otocorys alpestris*) was formerly a very rare bird in Great Britain, but may now be found not infrequently on the southern and eastern shores of England, and in Scotland as far north as St. Andrews. The bird so common in the warmer months on elevated moors is the so-called Titlark, which

is not a lark at all, but a pipit. The food of larks consists chiefly of insects and worms, supplemented by small seeds and herbage. The Skylark undoubtedly is injurious to wheat by biting the plantlets when germination is delayed, and before the leaf is 'in two blades'. The Skylark is especially abundant in the vicinity of arable or pasture lands. The Woodlark, as its name signifies, frequents wooded districts. It may be distinguished from the Skylark by its smaller size, very short tail, more conspicuous crest, and by the broad white stripe over each eye. The Shorelark may be at once recognized by the sharp contrast of black and white on its head. In all larks, the claw of the hind toe is usually much elongated. [H. S. R. E.]

Larkspur, the popular name for a large genus of herbaceous annual and perennial plants, many of which are cultivated in gardens. See DELPHINIUM.

Larva.—This is the name given to the early stage of all insects, as well as to that of several other invertebrates. Among the insects we find the larvæ of most of the Butterflies, Moths, and Sawflies to be more or less coloured or covered with hairs, either all over the body or arranged in tufts; these are usually called caterpillars.

The larvæ of the Butterflies and Moths never have more than sixteen legs, including the three thoracic pairs, and they never have legs on the fifth body segment; while the Sawfly larvæ can be distinguished by the presence of from eighteen to twenty-two legs, of which three pairs are thoracic, although we may find that many of the internal feeders are without legs. These Sawfly larvæ can also be distinguished by the presence of only one ocellus on each side of the head.

The larvæ of Beetles, which are often termed Maggots or Grubs, have usually six thoracic legs, although at times these may not be represented.

The larvæ of Diptera, or two-winged flies, are easily known by their legless condition, and in many cases the head is very small and can be withdrawn into the neck of the grub or maggot.

The larvæ of Plant Bugs, Greenflies, and certain of the Orthoptera bear a considerable likeness to their parents as regards general shape, but they never have wings; and the various parts, such as antennæ and legs, which are the six thoracic ones, have a thickened appearance compared with the compact and much more graceful finish of these organs in the perfect insect. [J. J. F. X. K.]

Laryngitis, inflammation of the larynx, a serious but not very frequent disease in its most acute form. Death may be caused by the swelling of the inflamed membrane, leading to partial occlusion of the breathing aperture. In less severe cases an irritation is left which too often results in chronic cough, thickening of the membrane, whistling, roaring, or wheezing, and in the case of horses reduces their value and usefulness. Warmly housed animals exposed to cold draughts out-of-doors are specially susceptible, and the disease also follows catarrhal affections, sore throat, bronchitis, and as a complication of influenza, glanders, purpura, &c. The symptoms indicate much distress and a feeling of bodily illness, increased temperature, a harsh, painful cough which the suffering animal tries in vain to suppress; restlessness, excitement, and fear, difficulty in swallowing, and refusal of food. The nose is poked out, and the inspiratory acts performed with labour and accompanied by a hissing or rasping sound, sometimes so loud as to be heard at a distance. The membranes of the eyes and nose are red or livid, the pulse quick and irritable, and the extremities cold. *Treatment* consists in the avoidance of all provocatives to coughing, as dust, decomposing manure and its ammoniacal vapours; a dry, clean bed, clothing, pure air, and a medium temperature. The steam of a kettle or frequent renewals of buckets of boiling water proves soothing. Inhalation of warm vapour from a bag of scalded bran, hot poultices round the throat, and an electuary spread upon the tongue at intervals of three or four hours and consisting of 1 dr. of extract of belladonna, 1 dr. of nitre, and 1 dr. of chlorate of potash, mixed with glycerine or honey, should be given in preference to any other form of medicament, owing to the extreme difficulty of swallowing. In cases of great difficulty in breathing it is advisable to insert a tracheotomy tube. See art. ROARING AND WHISTLING. [H. L.]

Lassoing.—The word 'lasso' is employed among horsemen and cattle ranchers almost throughout the American continent as a verb and as a noun. A lasso may be any kind of rope that can be thrown by a dexterous hand for the special purpose of catching an animal, and is usually made of hide with a running noose—lariat is a term of similar meaning. To lasso or capture by such means requires much practice, and the skill attained by Mexicans and by many so-called cowboys in the western States commands the admiration of all who witness it. Pursuing the devoted beast upon a horse trained to the work, an expert hand will cast the noose round neck, or horn, or leg of the animal and bring him down, or compel his movements in the desired direction, sometimes dismounting and springing again on to his horse's back with the agility of a cat. Much absurd romance hangs around the subject, but lassoing is no less a real accomplishment in daily practice in the countries above referred to. [H. L.]

Latent Heat.—When solids change into liquids and liquids into gases, heat is required for the transformation. To illustrate this, heat ice in a beaker, and notice that the temperature of the water formed will not rise until all the ice is melted. As soon as the last piece of ice has liquefied, the temperature will rise, and will continue to do so until the water boils, then it will remain stationary until all the water has been converted into vapour. The temperature of the vapour or steam will rise with further application of heat. If the vapour is then slowly cooled, the thermal conditions will be exactly reversed. Instead of heat being absorbed, it will be evolved, and at a certain temperature, that is, the temperature at which the water boiled, the vapour will condense back again to water; and the temperature will remain con-

stant until all the vapour has condensed. A similar change goes on when the water freezes. The quantity of heat given up during condensation and solidification is the same as that absorbed during liquefaction and volatilization.

The heat absorbed or emitted at constant temperature during change of state is called latent heat. It is insensible to a thermometer. The latent heat of different solids and liquids is widely different, but a definite quantity of heat is required to melt a given weight of any solid. The latent heat of fusion of a solid is the quantity of heat required to change a definite weight of a substance from a solid to a liquid state without change of temperature. In the same way it may be said that the latent heat of vaporization of a liquid is the amount of heat required to convert a given weight of the liquid into vapour without change of temperature.

The latent heat of fusion of ice is 79·2 thermal units, and the latent heat of vaporization of water is 536 thermal units. In other words, the above quantities of heat have to be absorbed by ice at 0° C. before it is converted into water at 0° C., and of water at 100° C. before it is converted into steam at 100° C. These same quantities of heat are emitted when the reverse change is in progress. [R. A. B.]

Laterite, a name given to red friable or compacted soils, often passing down into similar subsoils, which form in moist tropical climates from a great variety of rocks. Granite and slate may thus produce laterite; but a very frequent source is basalt. Laterite may in some cases be transported and laid down as a sedimentary deposit, becoming washed from slopes down on to the lower ground; but in the great majority of cases it arises as a sort of superficial iron-pan from the alteration of the underlying rock. By processes of transference, doubtless by solution under acid action, iron is accumulated in the higher layers of the rock, and this iron often appears as the anhydrous oxide hæmatite, instead of the common oxide combined with water, known as limonite or iron rust. Decaying vegetation may provide the acids in some cases, where tropical forests have spread over the surface; in other cases acid waters from subterranean sources may permeate the rock, and leave iron oxides where they evaporate away above in the hot air. All the structures of the original rock become lost in its upper layers as this remarkable transference of material goes on. Silica passes away from it in solution, and the percentage of alumina rises, so that some laterites promise to become available as commercial ores of aluminium. A brown-red to bright-red lumpy soil results, with tubes of iron oxide forming round rootlets, and with a tendency to become cemented locally. Stone implements fashioned by man are thus found cemented into the laterite of the Madras Presidency. See 'Geology of India', Geol. Surv. of India, 2nd ed., 1893, chapter xv; and T. H. Holland, Geol. Mag. 1903. [G. A. J. C.]

Laths.—Laths are mainly used to support plaster on ceilings and partition walls. Originally they were made from Norway spruce fir (*Pinus Abies*), and even now vast quantities of these are used, the wood being split or rended in thin slips about 1 in. in width; but the development of the Canadian lumber trade called for an opportunity for the utilization of short lengths, and large quantities of these are now sawn into laths. These laths are nailed to the under side of floorings and to uprights of partition walls, space being left between the laths, so that when the plaster is worked between them it forms a key on drying which prevents it falling off. During recent years there has been a considerable development in the building of party walls on skeleton metal frames into which plaster is worked, and where brickwork is not used. A good face can be got on these walls, consequently in such cases laths and further plastering are not needed. A stouter lath, known as slater's lath, is used for attaching slates to roofs. These are nailed at required distances to the rafters, and the slates are attached to them by lath nails. [W. J. M.]

Lathyrus is the botanical name for an extensive genus of leguminous plants, closely allied to the Vetch genus (Vicia), but distinguished by the comparatively small number of leaflets per leaf, and by the style of the pistil being flat, not threadlike (filiform). The common names applied to the species are vetchlings and peas; the common pea, however, is assigned to a special genus, Pisum, characterized by the specially large stipules, larger than the leaflets. The cultivated species are: (1) Sweet Pea (*Lathyrus odoratus*), a well-known garden annual with showy, sweet-scented flowers; (2) Everlasting Pea (*Lathyrus sylvestris*), a perennial with a creeping underground stem, and winged air stems 3 to 6 ft. high, bearing leaves with one pair of leaflets from 3 to 6 in. long and ½ in. broad. Flowers reddish-purple. This species has been recommended as a perennial fodder crop.

The common wild species of pasture and hedge is Meadow Vetchling (*Lathyrus pratensis*). It is a yellow-flowered perennial with creeping underground stem, and winged air stems 2 to 3 ft. high, bearing leaves with one pair of leaflets from ½ to 1 in. long.

The herbage of all species of Lathyrus is eaten by stock, but the seeds often act injuriously since they contain poisonous alkaloids. [A. N. M'A.]

Several species of Lathyrus are of considerable garden value, a judicious selection affording a prolonged flowering display. The perennial species should not be grown too formally; they may be allowed to roam over rockwork with good effect, to grow over walls or trellises, or among shrubs. The perennial kinds most usually grown are: *L. grandiflorus*, Two-flowered Everlasting Pea, rosy-purple flowers; *L. latifolius*, Everlasting Pea, flowers variable in colour; and *L. tuberosus*, a low-growing kind, flowers dark-pink. These may be propagated by division or from seeds. *L. odoratus*, the familiar Sweet Pea (which see), *L. tingitanus*, Tangier Pea, red-purple flowers, and *L. sativus*, Chickling Vetch, and its varieties are the best of the annual kinds. *L. splendens*, crimson flowers, is a fine greenhouse plant. Further important results are likely to be obtained from hybridizing this genus. [W. W.]

Laurel is the name applied in Britain to three different classes of shrubs or small trees, belonging to entirely different botanical families, and having no close botanical affinity whatever. In its stricter botanical sense it is a generic name commonly applied to the Lauraceæ or laurel family of plants, consisting of aromatic trees and erect shrubs with alternate, sometimes whorled and rarely opposite leaves, as a rule entire and mostly evergreen, some of which produce camphor, cinnamon, and other articles of commerce. The three shrubs called Laurel in Britain, and cultivated in gardens, are the following: (1) The SWEET LAUREL, or SWEET BAY (*Laurus nobilis*), the only true Laurel, belonging to the family Lauraceæ, which are usually evergreen shrubs with coriaceous leaves; with flowers solitary or in involucrate heads, often diœcious; with the fruit a one-seeded berry or drupe, often supported by the persistent perianth; and with timber often handsome and durable, though neither heavy, hard, nor forming distinct heartwood. The Sweet Laurel, indigenous to Asia Minor, Greece, Italy, and Northern Africa, but introduced into Britain in the 16th century, is a large evergreen shrub of 15 to 20 ft. high, but growing sometimes into a small tree over 50 ft. high, with large oblong or lanceolate, entire, leathery, shiny, aromatic leaves having a somewhat bitter flavour, though not poisonous like the Cherry Laurel. The flowers, produced in axillary clusters, are small, and yellowish white or green, and the fruit is a succulent, oval, bluish-black, aromatic berry about ½ in. long, surrounded by the persistent base of the calyx. Volatile 'oil of sweet bay' is obtainable from the leaves and fruit, formerly used medicinally, and the leaves are still used for flavouring in cookery. It is hardy, coppices freely, and has a strong reproductive power, making it suitable for ornamental hedges. There are many artificial varieties with curled, variegated, and otherwise distinctive foliage, and also a double-flowered variety, which can all be propagated by cuttings. (2) The CHERRY LAUREL (*Prunus Laurocerasus*), known as the Common Laurel, and the PORTUGAL LAUREL (*P. lusitanica*), which belong to the Cherry group of the Prune tribe of the Rosaceæ, have glossy evergreen leaves somewhat resembling those of the true Laurel, and are characterized by having numerous erect white disagreeably-scented flowers in racemes and smooth spherical drupe fruits without any bloom (characteristic of plums, to which they are closely related). The Cherry Laurel often ripens its small nauseous fruit in the warmer parts of Britain, but the Portugal Laurel only seldom does so. The Cherry Laurel is a hardy shrub indigenous to the Crimea, Asia Minor, the Caucasus and Persia, and was introduced into Britain during the 17th century, where it was soon largely cultivated in gardens for the beauty of its large, alternate, glossy, ovate lanceolate, thick, leathery, light-green foliage with slightly serrated edge. The leaves are characterized by glandular shallow depressions on the under surface near the base of the blade, one or two being on each side of the midrib. The leaves are poisonous, and when chopped and distilled yield prussic acid and oil of bitter almonds, a diluted form of which ('laurel water', made by macerating leaves for twenty-four hours and then distilling them) can be used for flavouring puddings and confectionery. It can easily be grown from seed, layers, or cuttings. Many garden varieties with characteristic foliage are propagated by cuttings. These include the *P. L. rotundifolia*, with short broad leaves; the *P. L. caucasiana*, with very rich, dark-green, glossy leaves (the handsomest, hardiest, and most vigorous variety); the broad-leaved or Versailles laurel, *P. L. latifolia*, with larger leaves; the dwarf or Colchican laurel (*P. L. colchica*), a low bushy shrub with pale-green, narrow, sharply serrated leaves; and many others. The Portugal Laurel, indigenous to Portugal and Madeira and introduced into Britain about 1648, is a less hardy species, more liable to be damaged by late and early frosts than the common Cherry Laurel, and less shade-enduring. It also differs from the latter in having darker-green and smaller leaves with closer and more regular indentation, and in being without any glands on the lower surface. Its racemes, too, are lateral. Owing to the difference in the colour, shape, and size of their foliage, the Cherry and the Portugal laurels contrast well in shrubberies. Several garden varieties of the Portugal Laurel are cultivated, the oldest being *P. L. myrtifolia*, with small narrow leaves and a compact habit of growth; *P. L. variegata*, with variegated foliage, and others. (3) The SPURGE LAUREL (*Daphne Laureola*), a small evergreen shrub with alternate, lanceolate leaves having entire margins, and green flowers with 4-cleft calyx produced in drooping clusters at the base of the leaves in early spring, which form green berries finally turning black and of a poisonous nature. The bark, too, is pungent and acrid. This and the closely allied Daphne or Mezereon (*D. Mezereon*), common in woods and with rich pink flowers blooming before the leaves appear, are the only two representatives in Britain of the family Thymelæaceæ. The LAURUSTINUS (*Viburnum Tinus*) has also no botanical connection with the true Laurels, as it belongs to the Elder tribe (Sambucus) of the Honeysuckle family, Caprifoliaceæ. [J. N.]

Laurus nobilis. See description of this tree in the preceding article under the subtitle 'Sweet Laurel'.

Lavatera (Tree Mallows), vigorous annual, biennial, and perennial plants (nat. ord. Malvaceæ), natives of the Old World. Only two species are commonly cultivated in gardens. These are: *L. trimestris*, an annual, growing 2 to 3 ft. high, and bearing large and striking white or rose flowers; and *L. arborea*, a biennial, best treated as an annual, which attains the dimensions of a large shrub, and is cultivated for its large, handsome leaves. These plants are best suited by a rich soil, and are easily raised from seeds. Those of *L. trimestris* may be sown in the open ground. [W. W.]

Lavender, a genus of Labiatæ (Lavandula) comprising about twenty species of perennial herbs or sub-shrubs with blue flowers, natives

of the Canaries, the Mediterranean region, and extending eastwards to India. The Common or Narrow-leaved Lavender (*L. vera*) is extensively cultivated for the oil obtained by distillation of the flower-heads with water, notably in the neighbourhoods of Mitcham in Surrey, and Hitchin in Hertfordshire. This oil is used in painting and in the production of lavender water, an agreeable perfume, while the dried flower-heads are sold in the streets and placed among handkerchiefs, &c., to scent them and to keep away moths. The Broad-leaved Lavender (*L. spica*) is also cultivated, but it is inferior to the preceding. Lavender is used for medicinal purposes, but not to the same extent as formerly. The flowers must be fully open before cutting takes place, and they should be slowly dried in a cool place. Lavender is also a favourite garden plant, appearing to the best advantage when massed. It delights in a deep light soil, and flourishes near the sea. Propagation is usually effected by cuttings inserted under handlights in autumn. *L. dentata* is not so hardy, and the large purple bracts of the less familiar *L. pedunculata* render this species well worthy of a place in the flower garden. [W. W.]

Lavender Grass. See MOLINIA.

Laverna atra. — This insect, commonly called the Pith Moth, is described in the art. BLASTODACNA VINOLENTELLA.

Lawes, Sir John Bennet.—The greatest agricultural experimenter who has ever lived was born at the end of 1814 in his ancestral manor house at Rothamsted, Herts. His father, who bore the same name, died when Lawes was only eight years old, and the Rothamsted estate was held in trust for him until he came of age. He was educated at Eton and Oxford; but his university life was a short one, as his tastes were strongly in the direction of chemistry, which he studied in the laboratory of Dr. A. T. Thompson at University College, London. There Mr. J. H. Gilbert, with whom his life was to be associated, was one of his fellow-students.

On entering into possession of his estate at Rothamsted, Mr. Lawes, as he then was, at once began to experiment upon plants, and his observations led to his invention of superphosphate of lime, for which he obtained a patent in 1842, and commenced shortly to manufacture. Early in 1843 he founded a fully equipped agricultural station at Rothamsted, and in June of that year he enlisted the co-operation of his former fellow-student, Joseph Henry Gilbert, who had taken the degree of Doctor of Philosophy at the University of Giessen (see GILBERT, SIR J. H.). Then began an association which lasted for fifty-seven years, and was terminated only by death. The great work carried on by the two friends is described elsewhere (see ROTHAMSTED).

Based on the yields of some of his experimental wheat plots, Mr. Lawes commenced an annual estimate of the wheat crop of the United Kingdom long before there were any official statistics on the subject. Beginning with the harvest of 1853, he gave the estimated acreage, total produce, yield per acre, net imports, and home consumption of wheat, with details as to the average price and the values of home produce and imports respectively. The particulars as to yield, imports, and quantity available for consumption were continued nearly up to the end of his life, and long after official estimates were first issued. Annual reports of the experiments were also issued by Messrs. Lawes and Gilbert. Either alone or in collaboration with his colleague, Mr. Lawes contributed a great number of articles to the Journal of the Royal Agricultural Society and other publications, commencing in the Journal in 1847, and ending in 1898. The Transactions of the Royal Society and the Journal of the Chemical Society were among the other serials in which the papers of Mr. Lawes appeared. Occasionally, but not frequently, he delivered addresses at the London and other farmers' clubs. Mr. Lawes, as he still remained, was elected a member of the Royal Agricultural Society in 1846, and a governor in 1878. In 1854 he was elected a Fellow of the Royal Society, which in 1867 awarded the Royal Medal jointly to himself and Dr. Gilbert. In 1877 the University of Edinburgh conferred upon Mr. Lawes the degree of LL.D., and later on Oxford made him D.C.L., and Cambridge D.Sc. Several foreign governments also conferred honours upon him and his colleague. In 1882 Mr. Lawes was created a baronet in recognition of his great services to agriculture. These services, it may be observed, were publicly recognized as early as 1854, when a large sum of money was collected in subscriptions. This, by Mr. Lawes's request, was devoted to the erection of a new laboratory at Harpenden, for use in connection with his experiments.

In 1893 arrangements for celebrating the jubilee of the Rothamsted Experiments were made at a meeting of the Royal Agricultural Society over which King Edward VII, then Prince of Wales, presided. In opening the proceedings the Prince alluded to the fact that the experiments had been carried on entirely at the expense of Sir John Lawes, and proceeded to state that Sir John had magnificently endowed them with £100,000, besides the laboratory and a portion of his landed estate. It was decided to erect a granite memorial in front of the laboratory at Harpenden, where the jubilee was celebrated in July, 1893. At the same time Sir John Lawes was presented with his portrait, painted by Mr. Hubert (now Sir Hubert von) Herkomer, R.A., and an illuminated address signed by the Prince of Wales.

The fame of the Rothamsted Experiments traversed the civilized world, and induced numbers of persons from this and other countries to visit the famous place. There they met with a hospitable and cordial welcome, and left with a kindly remembrance of the great man who had been their host, and, in many cases, the exhibitor and explainer of the experiments. To the workmen on his estate Sir John Lawes was kind, liberal, and considerate. Long before the public outcry for allotments and small holdings had arisen, he had provided his men with plots of land. All business in connection with them, and with a club established on the estate in a

building erected by Sir John Lawes, was managed by the men themselves.

Sir John Lawes died in August, 1900, in the eighty-sixth year of his age, leaving his renowned experiments to be carried on by the Lawes Agricultural Trust, which his munificence had created for that purpose.

[W. E. B.]

Lawn Mowers.—Lawn mowers have done much to improve lawns, as lawns as a rule are now far more frequently and better cut than when the scythe was depended upon. The best type of lawn mower is that in which the driving power is obtained from a heavy cylindrical roller, the spindle of which carries at one end a large gear wheel driving direct or by a chain to the spindle carrying the knives. The roller is provided with ratchets to allow a backward action, and the grass is rolled, cut, and collected in one operation. The cutting is effected by a series of blades placed helically on radial arms from the spindle, forming a cylindrical wheel; these shear off the grass as each blade in revolving comes into contact with a steel cutting plate placed below the cutting wheel. Machines of this type have the blades placed very closely together and are worked at high speed. Another type is that in which the roller is dispensed with, the driving power being obtained from two driving wheels which are the travelling wheels. The gearing is enclosed, and the cogs are placed on the inner periphery and actuate a spur pinion attached to the knife spindle. As in the roller lawn mower, the cutting is done by helically placed blades working against a fixed cutter bar. The blades, however, are set much farther apart; consequently they will cut much longer grass, but do not make such good work where it is short. In both machines the height of cut is regulated by an adjustable roller placed in front of the knives. The edges of the knives should be set so close to the edge of the cutter bar that they will cut a sheet of writing paper. Sharpening the knives is effected by revolving the blades backwards, simple provision for which is always made. [W. J. M.]

Lawns, Formation of. — In creating lawns two methods are adaptable, one by turfing, the other by seeding. But on account of expense, and the difficulty of procuring turf free from coarse meadow grasses and objectionable weeds, a mixture of grass seeds suitable to the soil to be sown down is more highly recommended, from the standpoint of economy as well as that of utility. Without including outlay on preparation of the ground, turfing costs about £100 per acre; seeding from £6 to £15 according to the quantity of seed used, which may range from 4 to 10 bus. per acre.

The preparatory work must be thoroughly carried out, the ultimate success or failure depending almost entirely on the initial operations being efficiently performed. Nothing ought to be stinted in quantity or quality, manure, labour or seed.

Ground facing north is preferable to any other aspect, while the most desirable soil for a lawn is a rich deep loam through which rain percolates freely. Where moisture is available for application during droughty seasons, it is now possible to make lawns on practically all classes of land, from a light sand to a heavy clay. Seedsmen with a sound knowledge of their business are able to prescribe mixtures of seeds to suit all soils and purposes.

Serious and careful thought should be given to the question of drainage, and the work ought to be placed in the hands of a competent man. On some soils natural drainage is all that can be desired; but where artificial drainage is indispensable, disappointment invariably follows if the work is hurried. After the pipes are laid, the ground must have opportunity to sink before further preparations are attempted.

Digging the soil to one spade deep is essential. When turning the ground well over, all large clods should be broken, stones, weeds, and roots being removed during the process. Irregularities in the conformation of the site should be corrected as the work progresses. If the soil is lacking in nutritive properties, advantage should be taken to incorporate some well-rotted farmyard manure, or, failing this, a reliable artificial fertilizer possessing nitrogenous, phosphatic, and potassic properties. Unremitting care at this period usually results in the ground being brought to the necessary pitch of perfection.

Attention to the surface is now required. Firm, level ground and a fine friable state of the soil are absolutely requisite, conditions brought about by diligently using the rake. After each raking, follow with the roller, so that complete pulverization of soil and consolidation of the entire area may ensue. The ground should at this stage be permitted a temporary term of idleness, enabling weed seeds to germinate, and successive crops to be destroyed by lightly scratching out the seedling plants as fast as they appear. In the case of soil brought from a distance, and about which nothing is known, this treatment is imperative, or disaster may follow if grass seeds are sown on ground impregnated with seeds of obnoxious weeds.

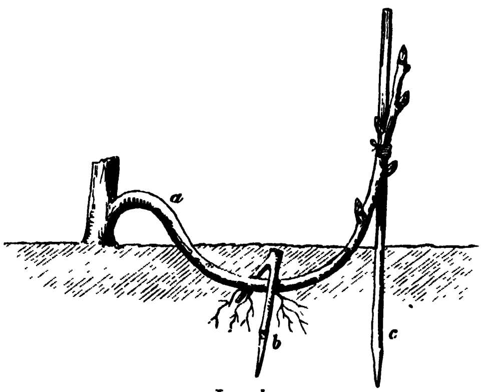
Having obtained the desired firmness, cleanness of ground, and fine tilth, the grass seeds may be sown; but, because of its importance, it must be reiterated that the mixture should depend on the nature of the soil, and be composed of proper hard-wearing lawn grasses in contradistinction to wide-leaved meadow grasses. The quantity necessary is touched upon in the opening paragraph. It is always desirable to sow thickly, as the more closely the plants are crowded together the finer and denser will be the herbage. Sowing operations are usually carried out from March to September inclusive. Autumn is generally considered superior to spring, as then the soil is moist, warm, and favourable to the quick germination of seeds. The prepared surface is lightly stirred with a rake, the seed evenly broadcasted by hand close to the ground, covered thinly with sifted soil or sand, and carefully rolled down; a quiet day should be chosen for the work. Protection from birds, in the shape of an irregular network of

black thread or a covering of netting, ought not to be overlooked.

Young grass requires careful treatment. When about 2 in. high it should be topped with a sharp scythe. Afterwards the mowing machine comes into use, and the sward ought not to be allowed to become benty or ragged. Rolling with a nicely weighted roller is obligatory, and should never be neglected. Mowing and rolling, when intelligently performed, induces a thick, velvety turf.

When established and in good condition, a lawn should be kept so by continually checking weeds, by judicious use of the mower and roller, and by frequent feeding. The particular form of plant food, which, of course, can only be applied as a topdressing, must depend on the soil, and expert advice on this important subject should be obtained from seedsmen who have made it their study. To emphasize this point it is only necessary to add that some grass lawns have been ruined by the application of certain fertilizers which directly encourage a strong growth of clover, while other artificial manures possessing exceptional forcing qualities stimulate a coarseness of leaf growth and are altogether inimical to the maintenance of fine springy turf. [M. H. F. S.]

Layering consists in raising new plants by pegging down and partially burying about 4 in.



Layering

a, Branch to be layered *b*, Hooked peg. *c*, Stick to keep shoot upright.

deep in earth or under sods of turf one or more branches or stool shoots. Any plants with strong reproductive power can easily be propagated thus, *e.g.* Elm, Lime, laurels, &c. Plants that are meant to be layered in the nursery are cut over at three or four years of age, like osiers; and in the following autumn the shoots that have flushed are bent over and layered into the ground that has been dug and cleared of weeds and stones, the shoots being pegged down and the upper end of each being left free to form the stem of the new plant. Roots form at the layered portion, and when the layered shoot is cut away from the parent stock it becomes a self-sustaining plant capable of being put into the nursery lines or out into the open. On such young plants being removed, the original shoots should be cut off close to the parent stool; and each autumn the summer flush of shoots is layered in turn. In dry weather, layering beds need watering. The Dutch method consists in bending down and layering the shoots in shallow trenches, and then separating them from the parent stools in the following autumn, and planting the rooted portions and about 4 to 6 in. of the stem above that in trenches. In the following autumn the shoots flushed from these new plants are all cut back; and of the next year's flush only the strongest shoot is left to develop as the stem, ready for planting out about five or six years later. Layering was formerly much practised in English coppices to fill blanks, and was known as 'plashing'. The shoots to be plashed were cut about half through with a bill, to be laid along the ground and pegged down, while at each of the joints a longitudinal cut was made on the lower side, and earth and turf were laid over the shoot; and as roots formed at the points several saplings were thrown out, which were two or three years later severed from the parent stool. If the shoot to be plashed be given a good firm twist, this also (especially with the Lime) acts like making cuts near the joints on the lower side in inducing the growth of independent rootlets—as the physiological disturbance thus caused probably tends to strengthen the natural effort at recuperation and reproduction. [J. N.]

Lazy-bed Cultivation.—A method of raising potatoes which is almost entirely confined to Ireland, though it is practised to a limited extent by some of the crofters in the Highlands of Scotland. Lea ground is invariably selected. Ridges 6 ft. wide are marked out, and each ridge is ploughed with a shallow furrow 3 in. deep. In some cases, however, only two shallow furrows at the borders of the ridge are ploughed, the centre of the ridge being left unploughed. Between the ridges a part of the green sod is left unploughed. Farmyard manure is now carted on to the ridges and deposited in heaps, 7 yd. apart, along the course of the bed. The dung is spread uniformly over the bed from these heaps, and the potatoes dropped in regular rows about 12 in. apart. Before or immediately after the spreading of the dung, a trench is opened along the green sod which separates the adjacent ridges. This is done either by throwing out two furrows with the plough, or by digging the sod with the long-handled spade. The potatoes now receive their first covering with about 4 in. of loose soil dug from the trench; they are then left untouched till the green shoots appear above-ground, when they are again covered with soil from the trench, the green shoots being completely covered. No further tilling is given throughout the season, except that a few weeds are occasionally pulled.

This system is to be recommended on cold, wet, stiff soils with impervious bottoms, on newly reclaimed bogland, or on badly drained soils, as the trenches lower the water level and allow of more efficient drainage. In districts where horse labour is scarce and expensive, where fields are steep and not adapted for horse

work, and where labourers are plentiful and cheap, the lazy-bed system is very common, especially in many parts of Ireland where such conditions do exist. On such soils potatoes come through the ground quicker, and the quality of the tubers is better, than where planted in drills. On dry soils, however, this system possesses no advantages and has many drawbacks. The soil is not so well tilled; little scope is given for cleaning the land, and consequently the ridges are often very foul and weedy, especially where the land is overrun with couch. Another disadvantage attends when much cold material from the bottom of the trench is thrown on the bed. Spraying operations also are rendered difficult. Lastly, when the land is laid out in such narrow ridges a suitable seedbed cannot afterwards be obtained. In many parts of Ireland this system is rapidly dying out. [N. L.]

Lea, or Ley.—The term 'lea' or 'ley' is generally applied to arable land under grass or pasture. The management of leas is discussed in the art. PASTURES, MANAGEMENT OF.

Lead and Lead Compounds.—Lead is a very important metal. It is found in very small quantities in the free state in nature. In the combined state it occurs very widely, and sometimes abundantly distributed as the mineral galena (lead sulphide). Other lead ores are anglesite or lead sulphate, litharge or oxide of lead, cerussite or lead carbonate. It is found also associated with arsenic, silver, copper, &c.

The crude metal as it is extracted from its ores contains many impurities. Some are removed by melting the metal in a shallow vessel and skimming off the dross as it collects on the surface. The dross consists of the oxidized impurities. Pure lead is a bluish-grey metal. When freshly cut its surface shows a bright metallic lustre, which, however, soon tarnishes on exposure to air. It is a very soft metal, easily cut by a knife or scratched by the nail. It leaves a black streak when drawn across white paper. Lead is very malleable and ductile; it cannot, however, be hammered into foil or drawn into wire, but it may be readily obtained in this form by rolling and pressing. The presence of impurities hardens the lead. It melts between 325° and 330° C., and becomes covered with a black film of the suboxide. When more strongly heated it forms litharge. It has a specific gravity of 11·3. Lead is soluble in nitric acid, but is insoluble in cold sulphuric and hydrochloric acid. Hot hydrochloric acid dissolves it.

On exposure to air, lead is readily oxidized, a white film of the oxide forming on the surface. Pure water from which the air has been boiled out has no action upon lead, but ordinary water in contact with lead forms the hydroxide, which is soluble in water, but afterwards becomes converted into the insoluble carbonate by the carbonic acid in solution in the water.

The corrosive action of water on lead is materially influenced by salts in solution. The presence of nitrates furthers the action, whilst chlorides, sulphates, carbonates, phosphates, and silicates hinder it, and sometimes effectively prevent it. It may be said that hard waters have no corrosive action on lead, whilst soft waters have. Lead in solution is poisonous, hence the corrosive action of some waters on lead is particularly important when leaden pipes and vessels are used for conveying and holding water for domestic purposes. Lead is used for a large number of purposes, some of the principal being for making pipes, gutters, spouts, shot, alloys, solder, as sheet lead for making sulphuric-acid chambers, &c. Lead forms a number of compounds which are used extensively in the arts. The following is an account of the composition and uses of some of the more important ores:—

Lead oxide (PbO).—There are two varieties of this oxide, namely, massicot and litharge; the former is a yellowish powder, the latter a scaly reddish solid. It is used for a number of purposes, such as in the manufacture of flint glass, as a glaze on earthenware, for the preparation of lead salts, plaster, putty, and in drying oils, &c. *Red lead* (Pb_3O_4), or minium.—This oxide is prepared from litharge by roasting in furnaces at a suitable temperature. It is a granular, heavy, crystalline powder. Commercial red lead varies somewhat in colour and purity; the pure oxide is a beautiful scarlet colour. It is used as a pigment. *White lead* is the basic carbonate of lead. It is a white, earthy, heavy powder used as a pigment in making white paints. Lead salts are poisonous, and cases of lead poisoning are known to occur from drinking water containing lead in solution, and by workmen engaged in the manufacture of lead salts. See art. LEAD POISONING. [R. A. B.]

Leading Cattle.—In order to facilitate the handling and movement of cattle, all young animals should be taught to be led. This can best be done when they are calves, at which age they are easily controlled and readily learn to follow when haltered. Animals so taught are much more tractable than those which have never been handled or accustomed to being led, and when they have to be moved from one field to another or one farm to another, one man can easily lead one or two animals, whereas if they have to be driven they are not readily controlled. It is much easier driving several animals than one or two. Full-grown animals which have been accustomed to be led when young never forget it, and ever afterwards go away quietly whenever a halter is put on their head. With old animals which have not been accustomed to be led, it is not only a difficult but a dangerous kind of work to attempt to lead them, and occasionally it has resulted in the death of a man. Small farmers usually attend to this work better than larger breeders, and in Denmark especially it is carried out very effectively. There cattle are rarely driven loose, each as a rule being haltered and tied to its neighbour, and in this manner they are led to and from the fields. There it is quite common to find one man leading ten to twenty cows to or from the fields, each moving as quietly as a lamb, and rarely ever showing any tendency to gore its neighbour. Animals which are accustomed to be handled are always less excited than others when strangers are attending to them. [J. S.]

Lead Poisoning.—Lead poisoning in animals is not met with in an acute form resulting

in immediate death, but rather as a cumulative and chronic condition as a consequence of feeding upon tainted ground, or inhaling the fumes of factories where the metal is chemically dealt with. It is an insidious poison, too often unsuspected until serious illness is established. On the land around disused lead mines, and where no mining has been carried on for perhaps a century, refuse lead has been oxidizing in the sun and wind and rain, and so acquires a soluble form capable of contaminating pastures and of poisoning animals grazed over them. The same thing has occurred in the neighbourhood of rifle butts. The symptoms are those of indigestion, capricious appetite, colic (see COLIC), obstinate constipation, hidebound, and staring coat, sunken eyes, and general malaise; no food appearing to benefit the rapidly emaciating subject. A diagnostic symptom which appears later is a bluish-grey line round the margin of the gums, consisting of deposited lead, and this becomes more pronounced if sulphur is given in the food, thereby producing a blackened sulphide of lead. When this stage is reached, muscular cramps and paralysis follow: the wasting is more rapid, nervous twitchings or convulsions are observed, and blindness, due to amaurosis (see EYE, DISEASES OF; AMAUROSIS, &c.), after which the animal dies. *Treatment* is hopeful if undertaken early enough, and it is most important, therefore, to form an early and correct diagnosis. The lead which has accumulated in the system can be precipitated by direct antidotes or chemical decomposition (see POISONS AND ANTIDOTES). The frequent administration of dilute sulphuric acid has the effect of producing a harmless and insoluble sulphate of lead, which is by degrees eliminated from the system. This process is also facilitated by repeated small doses of sulphate of magnesium (Epsom salts), which it is presumed breaks up into new compounds, allowing the acid radical (SO_4) to get free and unite with the lead as sulphate, in the same manner as when sulphuric acid is administered. The gentle aperient action is also beneficial in combating the obstinate constipation previously alluded to. Sulphur and potassium iodide are also given in daily small doses (see MEDICINES, DOSES OF), and play the part of eliminants. They are given separately, and at intervals of a few hours. Castor and linseed oils should be occasionally substituted for salts. [H. L.]

Leaf-box Beetle, a small weevil which is destructive to the leaves of many broad-leaved trees. See APODERUS CORYLI.

Leaf Miners. — Many species of insects belonging to various orders pass their larval stage below the epidermis of leaves, and are on that account called leaf miners. Almost all our broad-leaved trees, as well as other plants, are attacked by one species or another of the Micro-Lepidoptera, the members of the following genera being the more commonly met with: Lithocolletis, Nepticula, Cemiostoma, Lyonetia, &c., their attacks ranging through Oak, Hornbeam, Birch, Apple, Mountain Ash, Maple, Sallow, Hawthorn, Beech, Alder, Laburnum, Genista, Lotus, Chrysanthemum, &c. The larvæ feed generally through the summer, the perfect moths appearing in the early spring. Diptera are well represented among the leaf miners. Various species of the genera Phytomyza, Drosophila, Spilogaster, &c., may all be found upon low-growing plants both out-of-doors and in green-houses. Some species of beetles have the same habits, the most common of these being the larvæ of the various species of Flea beetles, the well-known Turnip Flea beetle being a good example. When these leaf miners are found to cause serious damage to the foliage of trees, future attack can be somewhat modified by the collecting of the leaves in the autumn and mixing with lime. [J. J. F. X. K.]

Leaf Mould is the term applied to vegetable matter undergoing the process of decomposition into its primary mineral constituents. It is a valuable form of plant food, classifiable as a mildly stimulating manure, and it is of especial value in woodlands. In agriculture, the larger the crops taken from the fields, the greater is the need of manuring; but in forestry, the larger the crops of timber, the better is the soil productivity safeguarded (and especially the moisture) by the thick crown of foliage and the leaf mould formed from the dead leaves shed. Thus, along with the greater portion of the mineral salts absorbed as food, larger supplies of carbon (drawn from the air) are given to the soil than were originally withdrawn from it; and the leaf mould, being of a hygroscopic nature, assists in condensing and retaining atmospheric moisture, and in preparing larger supplies of soluble mineral salts available for plant food through the action of the carbonic acid set free during the continuous process of decomposition; while the upper layer of dead and as yet undecomposed leaves protects the soil against the exhausting effects of sun and wind, and prevents the growth of rank weeds. Woodland soil is always improved, and to a greater or less extent deepened, by a moderate admixture of humus, although any excessive amount is injurious (as in peat bogs). Humus helps to modify all the extremes of physical properties in soil; and though not absolutely indispensable for timber growing, is yet of great value in stimulating the action of soil of any particular kind. A limy soil is quick in decomposing dead foliage, and a clayey soil forms leaf mould more slowly; while sandy and loamy soils form intermediate groups between these. It is always useful to have a leaf-mould pit near a nursery, in a well-sheltered place and with a sloping bottom and a ditch to carry off water. Into this all nursery weeds and rubbish can be thrown to rot; but care should be taken not to throw into this pit any weeds that have already flowered, else their seeds will sprout when the leaf mould is used on the nursery beds. Hence weeds that have flowered should be burned, and only their ashes thrown into the rubbish heap, or else at once used as manure whenever required, and a good addition of gas lime should always be made to the rotting heap, to hasten decomposition and prevent casual seeding. [J. N.]

League, a measure of length which varies in different countries. The British land league

is 3 statute miles; the nautical league 3 equatorial miles (= 3·45 statute miles).

Leap, or **Lip,** a measure of capacity now obsolete which contained half a bushel.

Leaping.—The leap is accomplished by first raising the forehand and then projecting the body off the ground by means of the hind limbs. The accuracy of this description is best proved in watching the animal at the standing leap. The high leap and the long leap and the running jump are differences only of degree, not in the principles by which they are performed. It is when the hind legs leave the ground that the animal is suspended in the air. When landing, the horse puts one fore foot upon the ground first, and for the fraction of a second sustains the whole weight upon it. In the canter and gallop it occurs when the leading fore leg is elevated. Greyhounds, felines, and buck differ somewhat in their leaping, and have two periods of suspension—one like that in the horse's leap, and another similar to that of his gallop, the former being the longer when at top speed. The greyhound also alters his two periods of suspension, and takes off again from the opposite fore leg from that upon which he commenced. Some species commence the gallop by a series of bounds or leaps, a method common to antelopes. Weight and conformation in animals belonging to the same species would seem to determine the manner in which they leap, the heavy St. Bernard performing in much the same way as the horse. The paces of animals have been very fully described and illustrated in The Horse in Motion (Leyland Stanford, photographs by Muybridge). Capt. Hayes's Points of the Horse may also serve the reader desirous of more fully entering into the details of animal locomotion. [H. L.]

Lease, Agricultural.—

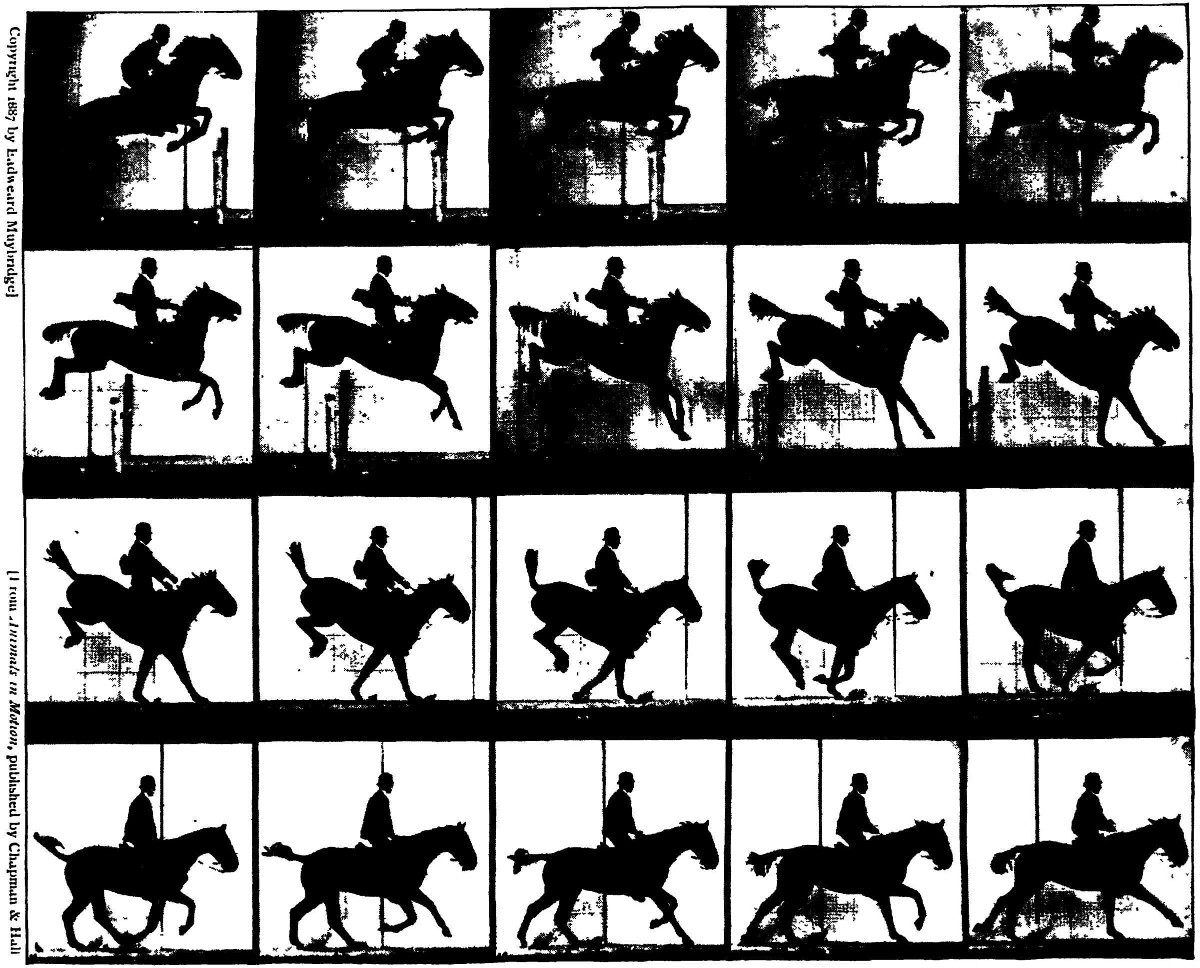
1. England

A lease is, in contemplation of law and fact, a conveyance of the demised premises for the term therein stated, subject to the rent, covenants, and conditions therein mentioned. A lease for three years or less may be written or verbal, but a lease for more than three years must be by deed, otherwise it is void (Real Property Act, 1845, sect. 3). An agreement for a lease need not, however, be by deed, but must be in writing and signed, and such an agreement for a lease may be enforced by an action for specific performance; and until a decree for specific performance is made, the tenant will be treated as holding on the terms of the agreement (Walsh *v.* Lonsdale, 1882, 21 Ch. Div. 9, 52 L.J. Ch. 2). The custom of the country is taken to be incorporated in every lease unless expressly or by necessary implication excluded.

In order that a lease may be valid, the landlord must have power to grant it. An owner in fee simple may lease the land for any term of years and as he pleases. Under the Settled Land Act, 1882, a tenant for life may lease the settled land or any part thereof in the case of ordinary (which include agricultural) leases for twenty-one years, but every such lease must be by deed, and take effect in possession not later than twelve months after its date, and must reserve the best rent that can reasonably be obtained. Any such lease must also contain a covenant by the lessee for payment of rent, and a condition of re-entry on non-payment of rent within a time therein specified not exceeding thirty days, and a counterpart must be executed by the lessor. Crown lands may be leased for any term not exceeding thirty-one years by the Commissioners of Woods, Forests, and Land Revenues. By the Ecclesiastical Leases Act, 1842 (5 & 6 Vic. c. 27), incumbents of benefices are enabled, with the consent of their bishop and patron, to lease lands belonging to their benefices (other than the parsonage and ten acres of glebe) for any term not exceeding fourteen years. By the Conveyancing and Law of Property Act, 1881 (44 & 45 Vic. c. 41), mortgagors of land while in possession, and also mortgagees of land while in possession, have power to make any agricultural or occupation lease of the mortgaged land for any term not exceeding twenty-one years, but every such lease must be made to take effect not later than twelve months after its date, and must reserve the best rent that can reasonably be obtained, regard being had to the circumstances of the case, but without any fine being taken. Every such lease must also contain a covenant by the lessee for payment of the rent, and a condition of re-entry on the rent not being paid within a time therein specified not exceeding thirty days, and a counterpart must be executed by the lessee and delivered to the lessor.

Leases of agricultural lands in England are not now so common as formerly, both landlords and tenants very usually preferring yearly tenancies, determinable upon one year's or six months' notice to quit, but leases are still occasionally granted where the certainty of a more prolonged term is thought desirable.

Leases and tenancies of any agricultural 'holding', which is defined by the Agricultural Holdings Act, 1908, as meaning 'any parcel of land held by a tenant, which is either wholly agricultural or wholly pastoral, or in part agricultural and as to the residue pastoral, or in whole or in part cultivated as a market garden, and which is not let to the tenant during his continuance in any office, appointment, or employment held under the landlord', are affected in several important respects by the provisions of that Act. These provisions include the right of the tenant to compensation for improvements, whether so agreed by the lease or tenancy agreement or not. This matter is fully dealt with in the article on the Agricultural Holdings Acts. They also include the right of compensation for damage to the crops of the tenant from game, the right to kill and take which is vested neither in him nor in anyone claiming under him other than the landlord (see article on Game Laws). A tenant by section 11 of the Act is, notwithstanding any agreement to the contrary, given compensation for disturbance if (*a*) the landlord 'without good and sufficient cause, and for reasons inconsistent with good estate management', terminates the tenancy by notice to quit, or having been requested in writing at least one year before the expiration



[From *Animals in Motion*, published by Chapman & Hall

THE LEAP: SUSPENSION, LANDING, AND RECOVERY

of the tenancy, refuses to grant a renewal of the tenancy or lease; or (*b*) if it has been proved that an increase of rent has been demanded from the tenant by reason of an increase in the value of the holding due to improvements executed by or at the cost of the tenant, and for which he has not directly or indirectly received an equivalent from the landlord, and such demand results in the tenant quitting the holding. The compensation recoverable is limited to the loss or expense directly attributable to his quitting the holding which the tenant may unavoidably incur upon or in connection with the sale or removal of his household goods or his implements of husbandry, produce, or farm stock on or used in connection with the holding. The Act also provides that a landlord or any person authorized by him may at all reasonable times enter on the holding for the purpose of viewing the state of the holding (sect. 24). There is also a provision in section 25 of the Act limiting the landlord's rights in the case of penal rents reserved by a lease or tenancy agreement. The Act further provides for freedom of cropping and disposal of produce by enacting that, notwithstanding any custom of the country or the provisions of any contract or agreement, a tenant shall have full right to practise any system of cropping of the arable land, and to dispose of the produce of the holding, without incurring any penalty, forfeiture, or liability, provided that he has made or shall make suitable and adequate provision to protect the holding from injury or deterioration, which provision in the case of disposal of the produce of the holding is to consist in the return to the holding of the full equivalent manurial value to the holding of all crops sold off or removed in contravention of the custom, contract, or agreement. This section does not apply in the case of a tenancy from year to year as respects the year before the tenant quits the holding, or any period after notice to quit has been given or received, or in any other case as respects the year before the expiration of the contract of tenancy, so that freedom of cropping and disposal of produce may still be restricted in the last year of the tenancy. If a tenant exercises his rights under this section in such a manner as to injure or deteriorate the holding, or to be likely to do so, the landlord may recover damages in respect of such injury or deterioration at any time, or may obtain an injunction restraining the exercise of the rights under this section (sect. 26).

For these and other provisions of the Act, see further the article on the AGRICULTURAL HOLDINGS ACTS in Vol. I.

According to the common usage the landlord executes the lease and hands it to the tenant to be kept by him, and the tenant executes and hands another exactly similar document, called the 'counterpart', to the landlord to be kept by him. When the lease and counterpart differ, the ordinary rule is that the lease prevails, unless the mistake is clearly in the lease.

The following stamp duties under the Finance Bill of 1909 are payable in leases or agreements for leases where the term does not exceed thirty-five years or is indefinite, if the rent, whether reserved as a yearly rent or otherwise, is at a rate or average rate—

	£	*s.*	*d.*
Not exceeding £5 per annum	0	1	0
Exceeding £5 and not exceeding £10 ..	0	2	0
,, £10 ,, ,, £15 .	0	3	0
,, £15 ,, ,, £20 .	0	4	0
,, £20 ,, ,, £25 .	0	5	0
,, £25 ,, ,, £50 ..	0	10	0
,, £50 ,, ,, £75 .	0	15	0
,, £75 ,, ,, £100	1	0	0
,, £100, for any full sum of £50, and also for any fractional part of £50 thereof	0	10	0

The counterpart must bear the same stamp as the original instrument if that does not amount to 5*s.*, and in any other case a 5*s.* stamp will suffice. If a lease is not stamped within thirty days after execution, the lessee incurs a fine of £10 (Stamp Act, 1891, sect. 15).

The following is a form of agricultural lease containing usual clauses for the protection of the interests of the landlord and tenant:—

THIS INDENTURE, made the day of , 19 , *Between* A. B. of &c. (hereinafter called 'the Landlord', which expression shall include his heirs and assigns where the context so admits) of the one part, and C. D. of &c. (hereinafter called 'the Tenant', which expression shall include his executors, administrators, and assigns where the context so admits) of the other part, *Witnesseth* that the Landlord doth demise and lease unto the Tenant *All* that farmhouse, buildings, and farm lands known as , in the County of , containing acres or thereabouts, more particularly described in the First Schedule hereto, and hereinafter called 'the Farm', *To Hold* the same (subject to all rights of way and easements) for the term of years, from the day of , 19 , but subject to the covenants, exceptions, reservations, and conditions hereinafter contained, *Yielding and paying* the yearly rent of £ by equal quarterly payments on the 25th day of December, the 25th day of March, the 24th day of June, and the 29th day of September in each year.

Exceptions and Reservations by the Landlord.—1. All mines, minerals, stone, gravel, and sand, with right of entry to get and work the same, making the tenant reasonable compensation for all damage done.

2. All timber and other trees, pollards, saplings, and underwood, with right of entry to fell and carry away the same, making the tenant reasonable compensation for all damage done.

3. Subject to the provisions of the Ground Game Acts, 1880 and 1906, all game, ground or otherwise (including nests and eggs), fish, wild fowl, woodcock, snipe, and landrail, together with a right for the Landlord and all persons authorized by him to preserve, hunt, shoot, fish, course, and sport.

And the Landlord hereby covenants with the Tenant:—

1. To pay or allow the Landlords' Property Tax, Land Tax, Tithe Rent Charge, and Drainage Rates.

2. To provide bricks, tiles, lime, and timber in the rough on the Farm, or within five miles thereof, for repairs when needed, and also to find gates at shillings each, and timber in the rough for gateposts, and in case of fire to allow a fair proportion of rent during the restoration of the buildings.

3. That the Landlord or his incoming Tenant will, at the expiration of the term, pay or allow a consuming price for any clover and straw left unconsumed on the Farm, and also for cultivation and acts of husbandry, according to the custom of the country and the terms of entry. *(This clause may require modification according to the practice of the district and the estate.)*

4. That the Landlord or his incoming Tenant will, at the expiration of the tenancy, pay or allow to the Tenant compensation for any improvements of the Tenant mentioned in Part III of the First Schedule to the Agricultural Holdings Act, 1908, according to the scale contained in the Second Schedule hereto, in lieu of and substitution for compensation under the said Act.

And the Tenant hereby covenants with the Landlord:—

1. To pay the rent and all rates, taxes, assessments, and other outgoings present and future, except as mentioned in clause 1 of the Landlord's covenants.

2. To preserve all timber and other trees, pollards, saplings, and underwood, from injury by cattle or otherwise, and not to cut, top, lop, prune, hang gates on, or destroy any timber or timber-like trees.

3. To reside in the farmhouse, and not to assign or underlet any part of the Farm.

4. To keep the dwelling house and all buildings, gates, stiles, roads, ditches, drains, watercourses, hedges, and fences of the Farm in good tenantable repair and condition, and so leave them on quitting (accident by fire or tempest excepted), being allowed by the Landlord necessary bricks, tiles, lime, and timber in the rough, to be carted by the Tenant at his own expense, and to cleanse and scour all ditches, drains, and watercourses, and to cut, trim, and lay all hedges as often as required.

5. To cultivate and manage the Farm according to the best system of husbandry and so as not to injure or deteriorate the holding or permit the same to be injured or deteriorated, and to leave the land in good heart and condition.

6. To cut, spud, and keep down all nettles, thistles, rushes, and tussocks, and to remove all mole and ant hills.

7. In the last year of the term to cultivate the arable land on the four-course system, having not more than one fourth part thereof in wheat and one fourth in barley or oats, and at least one fourth in roots, green crop fed off or fallow, and one fourth in clover or seeds, vetches or beans, of which last-named one fourth part not less than one half shall be in clover or seeds (*or such other provisions for the last year's cultivation as may be desirable, according to the nature of the land and the custom of the country*).

8. Not to break up any of the grass land, nor to mow the same or any part thereof, more than once in any year, nor more than two years in succession without sufficiently manuring the same.

9. Not to sell or remove, or permit to be removed, from the Farm any hay, clover, straw, roots, or green crops without bringing back and applying to the holding the full equivalent manurial value in manure or feedingstuffs of all hay, clover, straw, roots, or green crops so sold or removed.

10. Not to sell or remove, or permit to be removed, from the Farm any hay, clover, straw, roots, or green crops produced on the Farm in the last year of the term, and to leave any unconsumed hay, clover, and straw for the Landlord or incoming Tenant at a consuming price.

11. To spread and use on the Farm all dung, manure, and compost produced thereon, and on the termination of the tenancy to leave all unused dung, manure, and compost for the Landlord or incoming Tenant without compensation for the same, except for the labour expended on the same.

12. To keep all orchards and gardens in a proper state of cultivation, well manured, and in good heart, and to prune at proper seasons all fruit trees and bushes, and to replace those which die or become unprofitable by others of healthy and proper kinds.

Provided always, and it is hereby mutually covenanted and agreed as follows:—

1. The Landlord shall have power to re-enter and determine the tenancy on non-payment of rent for twenty-one days after the same shall have become due (whether legally demanded or not), or on breach of any of the covenants or conditions herein contained and on the Tenant's part to be observed and performed, and also in case the Tenant should become bankrupt or make any arrangement or composition with his creditors, or if any execution be levied against him or his effects; and upon any seizure by the Landlord under distress for rent, or by any person claiming under a Bill of Sale, the Landlord shall not be obliged to sell, and such other person shall not have power to sell, any hay, clover, straw, manure, or compost on the Farm upon the terms that the same may be removed from the Farm; but the Landlord may, and such other person shall, sell the same subject to the condition that the same shall be consumed on the Farm, and if so sold the Tenant shall allow the reasonable use of the yards and other accommodation for the purpose of such consumption.

2. All questions and matters in dispute and all compensations and allowances upon which the Landlord and Tenant fail to agree, arising under these presents or in respect of the tenancy hereby created, shall be referred to arbitration in accordance with the provisions of the Agricultural Holdings Act, 1908, but without prejudice to the option of the Landlord in respect of any claim against the Tenant, instead of submitting the same to arbitration, to have recourse to any right of action or other remedy.

In witness whereof, the said parties to these presents have hereunto set their hands and seals the day and year first aforesaid.

THE FIRST SCHEDULE ABOVE REFERRED TO.

No. on Ordnance Map.	Name of Field.	Description.	Quantity A.	R	P

THE SECOND SCHEDULE ABOVE REFERRED TO.

(To contain scale of compensation for improvements mentioned in Part III of the First Schedule to the Agricultural Holdings Act, 1908.)

Additions may readily be made to the above form of lease to adapt the same to the district where the land is situated, and to the varying circumstances of a Michaelmas, Lady Day, or Candlemas taking. The provision of a scale of compensation as above for improvements mentioned in Part III of the First Schedule to the Agricultural Holdings Act, 1908, is of course not necessary, as the matter may be left to be determined by valuation at the end of the tenancy; but such scales are in use by Tenants' Valuers' Associations, and will be found useful in preventing unnecessary disputes in the valuation of items of compensation. If it is desired to let a farm on a yearly tenancy instead of a lease for a term, the Agreement for tenancy may commence as follows:—

AGREEMENT made the day of , 19 , *Between* A.B. of &c. (hereinafter called 'the Landlord', which expression shall include his heirs and assigns where the context so admits) and C.D. of &c. (hereinafter called 'the Tenant', which expression shall include his executors, administrators, and assigns where the context so admits), whereby the Landlord agrees to let and the Tenant agrees to take the Farm lands and premises particularized in the First Schedule hereto and hereinafter called 'The Farm' (subject to all rights of way and easements), known as , situate in the Parish of , and County of , from the day of , 19 , and thenceforward from year to year, until the tenancy shall be determined by either party giving to the other one year's (*or* six calendar months') notice in writing, to expire at the end of any year of the tenancy, at the rent and subject to the agreements, reservations, and conditions hereinafter contained, at the yearly rent of £ per annum, payable quarterly on the usual quarter days, the first payment to be made on the day of next.

The rest of the Agreement may proceed as in the above form of Lease, substituting the words 'agree' or 'agreement' for 'covenant' where used, and 'tenancy' for 'term'. The witnessing part will be without seals as follows:—

'*As Witness* the hands of the parties the day and year first above written'. [A. J. S.]

2. SCOTLAND

Lease (*in Scots Law*) is a contract whereby the relationship of landlord and tenant is constituted, and may be defined as 'A contract whereby certain uses of land or other subjects are let on hire for a return in money, produce, or services'.

CAPACITY TO CONTRACT.—A pupil cannot enter into any contract which is binding on him, and consequently where the landlord is a pupil the lease will be entered into by his tutors or legal guardians. Trustees, including tutors and curators and judicial factors, appointed either on a trust estate or upon the estate of a person incapable of managing his own affairs, may, as an act of ordinary administration, enter into an agricultural lease for a period not exceeding twenty-one years, and into a mineral lease for a period not exceeding thirty-one years. The Court of Session has power, on proof of expediency, to give the authority to grant longer leases, but of course this power will only be exercised provided it is not at variance with the terms or purposes of the trust.

A pupil cannot enter into a lease as tenant, nor can he renew an old one. If, therefore, by inheritance, bequest, or gift he becomes lessee, his tutor or judicial factor would act for him, if he considered it advisable to carry on the venture. If the lease should expire during the term of office, it is a question whether the tutor or judicial factor is bound, or indeed entitled, to renew the lease. If he did, he would probably have to do so at his own risk should the tenancy result in a loss. A minor who has neither father nor curators, or a minor who has curators, with their consent may grant a lease, which, however, is liable to be reduced within four years after he attain majority, if he is able to prove that the lease has been granted to his considerable loss. But if a minor who has curators enter into a lease as tenant without their consent, it is probable that the lease would be reduced without proof of loss.

It is provided by the Agricultural Holdings (Scotland) Act, 1908, that where a landlord or tenant is a pupil or minor, or is of unsound mind, not having a tutor, curator, or other guardian, the sheriff, on the application of any person interested, may appoint to him a tutor

or curator for the purposes of the Act, and may recall the appointment and appoint another tutor or curator if and as occasion requires.

A married woman cannot grant leases of her separate property without the consent of her husband, except where the *jus mariti* and right of administration have been expressly excluded or renounced. Mere separation of the spouses does not of itself entitle a wife to grant a lease, but a decree of separation or of divorce entitles her to deal with her property as she may see fit.

On the other hand, if a lease has been granted to an unmarried woman who subsequently marries, the lease does not pass to her husband, but remains vested in her.

Trustees, as already mentioned, may grant a lease as an act of ordinary administration, to exist for twenty-one years in the case of agricultural lands, and for thirty-one years in the case of minerals. Whether they will be justified in becoming tenants will depend on the circumstances of each case, but there is nothing to prevent them entering into a lease, if for the benefit of the trust estate, and in accordance with the terms of the trust deed. But, of course, trustees cannot become tenants of the subjects entrusted to them in their trust capacity.

The power of commissioners or factors to grant a lease will depend entirely on their mandate, which ought to be in writing.

The rights of a proprietor under an entail to grant leases of land is regulated by the Entail Acts, and, speaking generally, except where the powers are limited by the deed of entail, he is entitled to grant leases of ordinary duration, but no grassum must be paid.

A liferenter may grant a lease, but it is only effectual during the period of his liferent. The owner of the property burdened with the liferent cannot grant an effective lease without the consent of the liferenter.

Subjects of Lease.—These are usually lands, houses, minerals, or other heritable subjects, but may also include such incorporeal rights as the use of water, the privilege of fishing, or of taking game.

Constitution of the Contract.—The formal constitution of the contract is usually preceded by preliminary negotiations followed by an offer and acceptance, on which the contract is based. The first essential is to ascertain clearly the conditions of let, for this will be the basis of the lease, and if they are to be in any way varied this must be stipulated in the offer. The acceptance must meet the offer precisely without qualification, for if any new stipulation be introduced this amounts to a counter offer, which is not binding on either party until accepted. All formal leases are constituted by writing, but there may be leases which, though not formally constituted, are nevertheless binding to a certain extent.

1. A lease for not more than one year may be proved by witnesses alone, without the necessity for any documentary evidence; but a verbal lease for more than one year is not good even for one year unless possession has followed on the alleged bargain. If, however, the tenant has entered into possession under a verbal lease for a series of years, the lease will be binding for one year, but (unless something more than mere possession has taken place) not for longer.

2. If there are documents which, through informality, are insufficient to constitute a binding contract, mere possession, if it is referable to these documents, is sufficient to 'put the documents in the same position as if they had been formally executed'.

A lease may be granted for a definite or an indefinite term, for a very long period or in perpetuity, or for the fulfilment of a condition, such as the repayment of a debt. But if no period of duration be mentioned, the result may be to hold that the lease is revocable at will. The necessity for making leasehold rights good against the singular successors of the landlord was recognized at a very early date, and the Act 1449, c. 17, protects absolutely tenants against the singular successors of the landlord, provided:—

(1) That the lease, if for more than one year, is in writing. But, as already pointed out, the writing need not necessarily be a formal lease, since an informal lease may be validated by the subsequent actings of the parties.

(2) That the subjects let be land. That is to say, land, houses, or any heritable subject capable of such possession as might naturally suggest to a singular successor the existence of a lease.

(3) That the lessee shall be in actual possession; but possession may be either natural, *i.e.* by a person holding in person, or civil, as by one holding through another, *e.g.* a subtenant, if sub-tenants are not excluded.

(4) That the lease shall be of a defined duration. As already pointed out, a lease without a definite ish may be bad even against the original lessor, and *a fortiori* such a lease will not bind a singular successor. But by the Registration of Leases Act, 1857, the registration of a lease for thirty-one years and upwards makes it effectual against singular successors whose infeftment is posterior in date to the registration of the lease. Thus by registration a lease of indefinite duration, provided it is clear it will endure in any event for not less than thirty-one years, may be rendered effectual against singular successors.

(5) That a rent shall be stipulated for in the lease, which, however, need not be in money, but may be in produce or personal services.

Assignability. — As leases involve *delectus personæ*, that is deliberate choice of tenant, they are not as a rule capable of being transmitted by the tenant to others. A relaxation of this rule is at common law made in favour of the heir of the tenant, and by Statute provision is made under the Agricultural Holdings Acts for a bequest of the lease. A tenant cannot, however, during his lifetime assign his lease or sublet the subjects except in the case of (1) liferent leases, (2) formal leases of extraordinary duration, and (3) leases of urban tenements, *i.e.* of houses in towns. Even in these excepted cases the implied power to assign and sublet may be, and usually is, expressly excluded by the terms of the lease.

Tenant's Rights under a Lease.—The primary right of a tenant is to be put into, and maintained in, the possession of the subjects let. He is entitled to demand entry timeously, and any serious delay whereby he is prejudiced would probably free him from the bargain. It is not a good answer for the landlord to say that the former tenant had refused to quit possession. That is a risk the landlord must take; and if he is unable to give his new tenant entry at the proper time, the tenant will, if seriously prejudiced, be entitled to throw up his lease, or go on with the lease and claim damages for the period during which he was precluded from the possession.

Difficulties sometimes arise as to the extent of the subjects let; and if the description be general, as the farm of A as occupied by B, this may require explanation to prove the extent of B's possession. In the case of a farm described by name and extent, and as occupied or having been occupied by a former tenant, then even if the extent mentioned prove deficient, no abatement of rent can be claimed, for in such a case the acreage is demonstrative, not taxative; in other words, the extent is not warranted, and of course the converse is also true. If, however, the farm is described by measurement which is warranted or made part of the contract, the tenant would be entitled to an abatement of the rent if the extent should prove deficient. In this connection it must be borne in mind that all contracts must be made according to imperial measure, otherwise they are void. 'Acre' therefore means an imperial acre, and it would not be admissible to prove that the extent would refer to Scotch instead of imperial acres. See under Weights and Measures.

Reservations in Favour of the Landlord.—The tenant's right under a lease 'is not understood to comprise every right which was before competent to the landlord, but is limited to these yearly fruits which either naturally or by the lessee's industry spring up from the surface'. Consequently there are certain reservations in favour of the landlord either implied at common law or expressly stipulated for:—

1. *Reservations Implied 'ex Lege'*.—(1) *Minerals*.—These are reserved to the landlord, with the right to work them, to gain the necessary access and to resume ground for the necessary works subject to payment of surface damages. Injury to land by subsidence does not ground an action at the instance of a tenant, but damage to the farmhouse or steading would. The landlord is only liable for such damage as properly follows from the operations which he carries on or has sanctioned, and is not liable for such damage or annoyance as, for example, that caused by trespass of the miners.

(2) *Woods*.—The woods on the farm are reserved to the landlord, together with the necessary access and accommodation for works. The tenant may cut willows if of the nature of withes, but not if they have grown into measurable timber. The woods may be let as an accessory of the farm, and in this case the tenant is entitled to cut trees for the erection or repairing of the necessary farm buildings, &c., but may not cut the wood for sale.

(3) *Game*.—The right of pursuing, taking, or killing game or fish of any kind is at common law reserved to the landlord. As to ground game, see under Game Laws.

2. *Conventional Reservations*. — These may be of any nature agreed upon, but are frequently variations of the implied reservations. Apart from these, however, the landlord frequently reserves power to resume land for planting, or, in the case of estates near towns, for feuing. The tenant cannot interfere with the landlord's discretion in selecting the land to be resumed, but, as a general rule, land on which buildings have been erected cannot be resumed except under special circumstances. The compensation to be paid for land so resumed usually takes the form of a reduction in rent, which, failing agreement, is usually stipulated to be referred to arbitration. In estimating the compensation, the value of the land resumed should be taken at the date of the resumption and not at the date of the lease.

Tenant's Right to be Maintained in Possession.—A tenant after getting possession is entitled to be maintained in the possession, and the obligation on the landlord is that he shall do nothing, and, so far as he can, allow nothing to be done, which will affect a tenant's possession of any material part of the lands. There may, however, be restrictions on the tenant's use of the land which would not be covered by the warrandice. Thus it has been held that where the subjects let were described as the farm of A, formerly possessed by B, the incoming tenant could not claim against the landlord on account of a servitude over the lands enjoyed by a neighbouring proprietor, since the tenant was presumed to have made enquiry. Moreover, the warrandice only gives rise to a claim against such acts as the landlord can himself control, and therefore if loss arises from the subsequent passing of a law the tenant must suffer the loss. Nor will the landlord be liable for loss occasioned to the tenant by an act, lawful or unlawful, of a third party. If the act is lawful, both the landlord and the tenant must be held to have taken the risk of it, and if it is unlawful the tenant has a right to proceed against the third party for loss sustained. Eviction from the premises may be either partial or total, and may take place through default in the landlord's title, or through some act on the part of the landlord. Apart, however, from the question of the landlord's title, or any act done by him, circumstances may occur which practically dissolve the relation of landlord and tenant, and in such a case the tenant may be entitled to abandon the lease. Thus, through fire or some cause outwith the power of the tenant, the premises may be rendered unfit for the purposes for which they were let, but the cause must be outwith the tenant's power; for if the premises are burned through the fault of the tenant, the burden of repairing the loss would be thrown on him. If, however, the accident occurred without fault either on the part of the landlord or the tenant, then:—

(1) There is no obligation on the landlord to restore the subject to its former state. Thus he is not bound to rebuild a house burned by accidental fire.

(2) The tenant is under no obligation to restore, and it makes no difference that there is a clause in the lease binding him to uphold the premises in a tenantable condition and so leave them at the expiry of the lease. Such an obligation in Scotland is held not to refer to a purely accidental loss.

In these circumstances, if the landlord does not desire to restore the premises a claim for abatement of rent will emerge, or, if the destruction is material, the tenant may throw up the lease, but no claim for damages will arise to either party. If, however, the landlord offers to restore the premises, it is a question depending upon the circumstances of each case whether the tenant is entitled to abandon the lease, or is bound to continue in the tenancy subject to an abatement of rent. For although the damage done may not be sufficient to warrant a tenant in throwing up the lease, there will be a claim for some abatement of rent. 'Where through no fault of his own a tenant loses part of the subjects let to him, he is entitled to an abatement of rent.'

In order to provide against fire risks, the property is usually insured by the landlord, the tenant being taken bound to pay half the premium. If, however, there is no express obligation on the landlord to restore the property, the tenant cannot insist on his doing so, although he has recovered the sum in the policy from the insurance company. It is therefore usual to stipulate that in the event of a loss the landlord shall expend the sum to be recovered in restoring the buildings. But even under such a clause he is not bound to expend on restoration more than he actually receives from the insurance company.

Tenant's Obligations. — *To take and retain Possession.*—The tenant is bound to enter into possession of the farm, and if he refuses or delays to do so an action may be raised to compel him, or failing that, to pay damages. The tenant is further bound to continue in the possession of the subjects failing some good legal ground of renunciation of the lease. His failure to do so will justify the landlord in bringing the lease to an end or claiming damages. Personal residence may be stipulated for, but failing this, occupation by the tenant's grieve or other person on his behalf will be sufficient compliance with the requirements.

Not to invert Possession.—The tenant is not entitled, without the landlord's consent, to change the use of the subjects let.

Upkeep of Buildings, Fences, &c.—The landlord, apart from stipulation, is bound to put the houses, offices, and fences on the farm on the tenant's entry into a state of tenantable repair, *i.e.* such a state of repair as will, with respect to the houses and offices at least, render them capable of lasting with ordinary repair to the termination of the lease, and with regard to fences, as will render them capable of lasting 'well into the lease, and not necessitate a new tenant making extensive repairs on them from the day he enters the farm'. This obligation only extends to the buildings, fences, &c., actually on the ground at the date of the lease, and there is no implied obligation on the landlord to erect further buildings or to fence unfenced ground. If the landlord fail to implement this obligation, the tenant may by an action compel him to do so, or pay damages for the breach. In the event of the breach of a condition which is material and serious, the tenant may be entitled to abandon the lease.

After the fences, buildings, &c., have been put into habitable repair, the tenant is bound to uphold them in a like condition, and so leave them at his removal. But this obligation is subject to two exceptions:—

(1) Ordinary tear and wear is always excepted. So, too, natural decay arising from defective structure would not justify the landlord in calling upon the tenant to restore the buildings. Wherever there is a case of what may be called extraordinary repairs, the obligation to restore is on the landlord.

(2) The tenant is not responsible for damage due to causes beyond his control, such as accidental fire.

The obligations above referred to are implied by common law, but the questions are usually settled by special agreement in the lease. Thus it is usual to stipulate that the tenant shall accept the buildings, fences, &c., as in good tenantable order at the date of his entry, and shall keep them in the like good order. If the tenant accept such a clause, he cannot thereafter complain of the condition in which they were at the date of his entry. Another arrangement which is common, is for the landlord to assign to the incoming tenant his claims against the outgoing tenant to put the buildings, &c., into good tenantable repair, and as a condition of this assignation the tenant is taken bound to accept them as in sufficient order. It should be borne in mind that the outgoing tenant is not bound to make repairs necessitated only by ordinary tear and wear or natural decay, and that consequently his obligation may be fulfilled without putting the buildings, fences, &c., into such a condition as an incoming tenant would be entitled to demand from the landlord. If a tenant fail in his obligation to uphold the buildings, fences, &c., and leave them in a good state of repair at his waygoing, the landlord has a claim for damages which he may state in answer to any claim by the tenant under the Agricultural Holdings Acts.

The date of entry is almost always stated in the lease, and the usual terms for entry are as follows: In the case of arable farms in the south and east of Scotland, at Whitsunday to the houses, fallow lands, and grass, and at the separation of the crops thereafter to the lands under crop. In the west of Scotland the entry is usually to the arable lands at Martinmas, and to the houses, &c., at Whitsunday thereafter. Sometimes entry is given to the whole subjects at Martinmas. In the case of pastoral farms, the usual date of entry to the whole subjects is at Whitsunday.

The rent of the lands is due for each crop and possession of each year separately, although for convenience it is invariably payable at two terms in the year. The year in a farm ends with the separation of the crops, that is to say, at Martinmas. The rent is due one half at the term of Whitsunday preceding the reaping of the crop, and the next half at Martinmas thereafter. The payment must be made at the due date to the proprietor or someone having his authority to receive it, and in exchange a formal receipt ought to be got, for where a lease is constituted by writing, payment of rent can only be proved by writ or oath. If, however, the tenant can produce the receipts for three consecutive terms of rent, it is presumed that all preceding rents have been paid. The tenant has a right, however, to set off against the landlord's claim for rent, a debt consisting of an ascertained sum of money which is due at or before the term for payment of the rent. But the debt must be both due and ascertained, and therefore a claim for damages, the amount of which has not been fixed, cannot be set off against the payment of rent. If, however, the landlord be bankrupt and due the tenant a sum of money, whether the amount be ascertained or not, the tenant has a right to retain any arrears of rent sufficient to meet the debt. This is an equitable exception to prevent the hardship of the tenant's having to pay the landlord's trustee in bankruptcy the full amount of the debt due by him, and on the other hand only receiving a dividend from the bankrupt estate on his own claim. Moreover, where a landlord has failed to put and keep his tenant in possession of a material part of the subjects, or where he has failed to implement his obligation to put the farm buildings into a habitable condition and repair, the tenant will be entitled to retain his rent until the landlord has fulfilled his part of the contract. If, however, the ground of retention is an allegation that the landlord has failed to implement a condition which is merely collateral to the principal obligation of putting and keeping the tenant in possession of the subjects let, the tendency of the Court is to refuse to allow the tenant to retain his rent as a set-off to the unascertained damage he has sustained by the breach. For this he must sue the landlord. In any event it must be borne in mind that in order to enable a tenant to retain his rent he must make his claim timeously, otherwise he will be barred from setting it up as a defence to an action for payment of rent. Thus a landlord or tenant at the conclusion of a lease for a term of years is not entitled to go back and claim damages for injuries sustained during the currency of the lease, the tenant having paid rent without making any specific claim of damages, or, on the other hand, the landlord having given no notice of his demands.

In urban leases the landlord, as security for payment of the rent, has a right of hypothec over the moveable goods for the subjects let. Formerly the landlord of agricultural subjects had a similar right, but by the Hypothec Abolition (Scotland) Act of 1890 it was abolished as regards all lands exceeding 2 ac. in extent let for agriculture or pasture. (See HYPOTHEC.) In all cases in which the landlord's right of hypothec for rent has ceased, he has, however, the right to remove the tenant for non-payment of rent, as to which, see under AGRICULTURAL HOLDINGS ACTS.

In the event of non-payment of the rent the landlord has all the usual remedies for recovery of a debt, but in addition he has, in the case of a formal lease, the right of summary diligence following on the decree of registration. All formal leases contain a registration clause to the effect that the parties thereto 'consent to registration hereof for preservation and execution', which imports a consent to registration in the Books of Council and Session or other competent Books, and is thereafter equivalent to a decree by the Court, on which it is competent to arrest the readiest goods, debts, and sums of money of the debtor mentioned in the extract, in payment and satisfaction of the obligation therein specified under pain of poinding.

RULES OF MANAGEMENT AND CULTIVATION.—Formerly it was customary to embody in leases of agricultural subjects certain regulations as to the management and cultivation of the ground, and, even where the lease was silent, there were certain recognized rules which were held by implication to be binding on the tenant. These implied rules may be summarized as follows:—

(1) Every lease was held to imply an obligation on the tenant to conform to the rules of good husbandry.

(2) One or other of the rotations in practice in the district had to be followed, if suitable to the lands.

(3) A tenant was not at liberty to sell off the farm straw, turnips, or green crop, 'unless he either bargains with the purchaser for the dung produced from it, or purchase as much for the use of the farm'. To this rule there was the exception that, apart from express stipulation in the lease, a tenant was at liberty to sell or consume his waygoing green crop off the farm. He was also entitled to the waygoing white crop, sown before the Whitsunday of removal, and to the hay crop reaped shortly after that term, for which purpose he was entitled after his removal from the houses, to access to the lands to reap the crop. Moreover, if he left fallow land off which he might have taken another crop, he was entitled to receive from the landlord, or incoming tenant, the difference between the return from the farm during the last year, with the fallow so left, and what it would have been had a crop been taken off the fallow land.

(4) The whole dung produced on the farm must be applied to the cultivation of the lands. On waygoing, however, he was entitled to sell the manure not applied since the laying down of the last green crop, but the incoming tenant had a preferable right to it on payment of its value.

By the passing of the Agricultural Holdings Act, 1906, these rules were to a large extent swept away; and although that Act has since been repealed by the Agricultural Holdings (Scotland) Act, 1908, the latter Act contains

provisions to the same effect as the former Act, whereby the tenant is entitled to freedom of cropping and the right of disposal of his produce. The provisions of the Act are as follows:—

(1) Notwithstanding any custom of the country, or the provisions of any lease or agreement respecting the method of cropping of arable lands, or the disposal of crops, a tenant of a holding shall have full right to practise any system of cropping of the arable land on the holding, and to dispose of the produce of the holding, without incurring any penalty, forfeiture, or liability:

Provided that he shall previously have made, or, as soon as may be, shall make, suitable and adequate provision to protect the holding from injury or deterioration, which provision shall in the case of disposal of the produce of the holding consist in the return to the holding of the full equivalent manurial value to the holding of all crops sold off or removed from the holding in contravention of the custom, lease, or agreement.

This subsection shall not apply—

(*a*) In the case of a tenancy from year to year, as respects the year before the tenant quits the holding, or any period after he has given or received notice to quit which results in his quitting the holding; or

(*b*) In any other case, as respects the year before the expiration of the lease.

(2) If the tenant exercises his rights under this section in such a manner as to injure or deteriorate the holding, or to be likely to injure or deteriorate the holding, the landlord shall, without prejudice to any other remedy which may be open to him, be entitled to recover damages in respect of such injury or deterioration at any time, and, should the case so require, to obtain an interdict restraining the exercise of the rights under this section in that manner, and the amount of such damages may, in default of agreement, be determined by arbitration.

(3) A tenant shall not be entitled to any compensation in respect of improvements comprised in Part III of the First Schedule to this Act, which have been made for the purpose of making such provision to protect the holding from injury or deterioration as is required by this section.

(4) In this section the expression 'arable land' shall not include land in grass which by the terms of any contract of tenancy is to be retained in the same condition throughout the tenancy.

Termination of the Lease. — A lease is brought to an end either—

(1) By termination at the ish, *i.e.* the expiry of the period contemplated by the lease, or by the occurrence of a break in favour of one or other of the parties or of both, advantage of which is taken.

(2) By the occurrence of a conventional irritancy stipulated for by the lease.

(3) By the occurrence of a statutory irritancy, *e.g.* removal for non-payment of rent.

(4) By the bankruptcy or insolvency of the tenant, if by the lease it is provided that this is to terminate the contract, for bankruptcy does not *ipso facto* bring a lease to an end.

(5) By such destruction of the premises as will warrant the tenant abandoning the lease as already explained.

In the case of agricultural leases, special provision as to notice, tacit relocation, &c., is made by the Agricultural Holdings Acts. See Agricultural Holdings Acts. [D. B.]

Leather Industry.—The manufacture of leather from the hides and skins of animals is undoubtedly one of the most ancient practices of man, and was probably one of his earliest attempts to utilize his available materials. Amongst every race of men, and in all periods of human history, the preparation of animal skin for application to useful purposes seems to have found a place, and in the less civilized parts of the world there may even yet be seen the most primitive methods for accomplishing this purpose, such as the curing of skins by smoke, or by treatment with soft fats, or merely by drying. To make 'leather' from skin it is necessary that the raw material should be 'tanned', but it is not possible to define very closely what is meant by this term. It may be said, however, that the material is so changed that it is to some extent permanent and lasting, and no longer subject to putrefaction and decay. At the same time it is necessary that the product should possess without brittleness some degree of flexibility, and sometimes the property of waterproofness. In most cases also it is customary to remove the hair from the skin before the 'tanning' proper, and to subject the tanned skin to various finishing processes which improve both the quality and the appearance of the final product.

The Raw Material of the leather industry is obtained from almost all animals, but most extensively from cattle, sheep, and goats. The skins of all these animals possess a great deal in common in their general physical structure, so that the methods of treatment require only slight modification for the different classes of goods. Animal skin may be divided into two distinct layers, the epidermis (epithelium or cuticle), which forms the outer and much thinner layer, and the corium (cutis or derma), which forms the greater part of the skin. The *epidermis* is composed of minute cells of nucleated protoplasm which increase rapidly by division. This multiplication causes the older cells to be pushed towards the outer surface and to become flattened and dried, thereby forming the outmost horny layer of the skin. The hair, horns, hoofs, and other similar structures are also evolved from the epidermis, though their roots often sink for some distance into the corium. The *corium* differs considerably from the epidermis in structure, being composed of fibrous material known as 'hide substance'. The fibres which make up this connective tissue are in interlaced bundles, and are built up from extremely minute fibrils which are cemented together by a gelatinous substance. In between these fibre bundles there are found nerves, bloodvessels, and the muscular 'elastic fibres', which last seem to consist of different material. There is

also a variable amount of 'interfibrillar substance' from which the fibres are built up. The interlacing of the fibres is least compact in the middle of the corium, but becomes very tight in that part next to the epidermis, which part forms what is known as the 'grain' of the leather. This grain has a very characteristic pattern for different classes of hides and skins, and may be very easily damaged by mechanical or bacterial action. In the corium also are situated the sudoriferous or sweat glands, which are excretory organs, and the sebaceous or fat glands, which lubricate the hair through minute ducts of an epithelial nature.

The chemical nature of all the constituents of skin is very closely similar in spite of their difference in structure. They are all classed with the 'proteids', which are complex organic substances containing 49 to 55 per cent of carbon, 15 to 19 per cent of nitrogen, $6\frac{1}{2}$ to $7\frac{1}{2}$ per cent of hydrogen, 17 to 26 per cent of oxygen, together with small quantities of sulphur and phosphorus. The epidermal structures are composed of proteids of the *keratin* class, which are insoluble in cold water and only softened somewhat in hot water. The softer keratins (*e.g.* the hair root) are dissolved by strong alkalis (*e.g.* caustic lime), but the harder keratins require heat. They are all dissolved readily by solutions of sulphides. The corium is composed chiefly of proteids of the *gelatin* class, which are almost insoluble in cold, but dissolve in hot water, doubtless with some hydrolysis. These gelatinous substances are only slightly attacked by solutions of caustic alkalis and sulphides in the cold, but are caused to swell considerably. In the absence of a definite physical structure such as is found in hide substance, the gelatins form the well-known 'jellies'. The serum of the bloodvessels and the lymph which nourishes the skin belong to the *albumin* class of proteids, which are soluble in cold water, and are coagulated by heating to about 70° C. (as in the white of egg).

The raw material of the leather industry consists of 'hides' and 'skins', the commercial distinction of which is based chiefly upon the size of the animals, but partly also upon the age and the class of leather for which they are intended to be used. Hides, which are obtained from the larger and adult animals such as the ox, heifer, bull, cow, buffalo, horse, walrus, hippopotamus, and camel, are used for the manufacture of the heavier leathers, such as sole, belting, harness, and upper leather. Skins, which are obtained from the smaller and younger animals such as the sheep, calf, goat, seal, pig, and deer, are employed for the manufacture of the lighter and fancy leathers; and to some extent the skins of alligators, serpents, lizards, and fish are used for similar purposes.

Although the hides of cattle are procured largely from British slaughter-houses, the leather industry in Britain is now so extensive that it requires material from other sources, and immense quantities are therefore imported from all parts of the world. In this case it is quite necessary that they should be 'cured' or temporarily preserved from decomposition and decay, and this is brought about usually by one of the three chief processes, viz. drying, salting, and dry-salting. In curing hides by drying, the elimination of water causes the hide to become hard and horny (hence the term 'flint' hides), but the absence of moisture effectively prevents any putrefactive action. The process is difficult to carry out satisfactorily, and the hides always wet back with difficulty, but where land transit is considerable or salt is dear, it is often the only practicable method. The operation is best accomplished by a good draught and a low temperature, with possibly the use of carbolic acid or some other antiseptic. Salting hides is perhaps as good a method of cure as any yet suggested. Common salt is hygroscopic and mildly antiseptic, and by its use well-preserved hides will keep undecomposed for a considerable period. This method is extensively employed in the stockyards of Chicago for the curing of the so-called 'packer hides'. The work in this case is most systematically arranged, and carried out in a painstaking manner. The hides are trimmed, salted with about 25 per cent their weight of salt (chiefly on the flesh side), and stored in large packs for about a fortnight in cool cellars. Dry salting is another efficient method of curing which consists of a combined drying and salting. It is a method used in some of the large South American slaughter-houses and also in curing 'East India kips', the hides of a small species of Indian cattle, the salt in this latter case being a sodium sulphate earth.

The commercial value of hides is dependent upon their origin, their age, and their freedom from certain common defects. The nature of the hide is very distinctly influenced by the conditions of the animal's life, and it is now well known that those animals which come from mountainous districts and are exposed to adverse climatic conditions yield the best hides, having usually compact texture, good grain, and considerable thickness. Animals coming from lowland regions and those bred for milk-producing qualities (*e.g.* the Dutch cow) are liable to give poor thin hides. Stall-fed animals are often very badly rubbed in the neck, which fact reduces their value and makes the tanner's work more difficult. The young animals, such as the calf, lamb, and kid, yield well-filled skins with a very soft and milky texture, and give a very compact and fine grain. The old animals, on the other hand, such as the bull and cow, yield hides which are often rough and wrinkled and have coarse fibres containing little interfibrillar matter. Bull hides are usually of less value on account of their thinness in the back and thickness in the neck and belly. The hides of the ox and heifer are, of course, intermediate in texture. The value of hides is also influenced considerably by the care which is taken in flaying. The aim should be to detach as much fat and flesh as possible without cutting the skin itself. Doubtless some experience is necessary for satisfactory work, but this important operation is nevertheless often very carelessly done. Hides are also seriously impaired in value by scratches due to hedges and barbed wire, drovers' goad marks, scabs, tar marks, and brands. The

last mentioned are particularly objectionable, as the brand sinks usually right into the grain in the most valuable part of the butt. The presence of warble holes or marks is another serious defect in hides. These are due to the Ox Warble Fly, or Bot Fly (*Hypoderma bovis*). Warbled hides are sold at distinctly lower prices than undamaged hides, for the leather made from the former is obviously useless for many purposes where the material must be wind- or water-tight. As this defect gives rise to very serious losses, it would seem a matter of some importance both to farmer and tanner that some steps should be taken to reduce this pest, but as yet little has been attempted. Hides are bought and sold by weight, and are so classified in the principal markets, the weight of each being marked on the tail-end. This is known as the 'tail weight'. As the amount of leather to be obtained is proportional to the amount of 'pelt', *i.e.* the hide unhaired and prepared for tanning, the best hides are those which give the best yield of pelt. It will be clear, therefore, that hides with short hair and small horns, or those weighed without horns, are the most economical to buy. It is customary for many purposes to 'round' hides into 'butts', 'shoulders', or 'bellies', and as the butt is the most valuable portion of the hide, animals with short necks and legs yield the best hides. Another objectionable feature in hides is grease, for this causes many difficulties both in tanning and finishing.

Of the English breeds the Herefords yield some of the best hides. They are usually of good texture, free from grease, and give a good yield of butt pelt. They are very suitable for the manufacture of sole and harness leather. Shorthorns yield hides of rather varying quality, and on account of high feeding for show purposes, some are apt to be very greasy. Devons yield well-grown hides of good texture, but are often very badly warbled, which makes them unsuitable for high-class or chrome work. The Sussex cattle are somewhat liable to give poor yields of butt pelt. Suffolk Red Polls yield well-grown hides, those from the cows being particularly suitable for chrome and dressing leathers. Channel Island cattle (Alderneys, Guernseys, and Jerseys) yield somewhat thin hides, but as they are often well groomed they usually have a good undamaged grain and no warbles. All the Welsh breeds yield good stout hides. Of the Scotch breeds, West Highlanders (Kyloes), Polled Aberdeen-Angus, and Galloways all yield good well-grown hides. The Scotch Shorthorns are amongst the best hides procurable, especially for the manufacture of sole leather, as they are well grown, thick, short in neck and leg, small in head, and usually well flayed. They also yield an excellent percentage of butt pelt. Ayrshires yield hides which are not so good, being often thick in the belly. Irish hides have a somewhat bad reputation, being mostly thin, light, coarse-textured, and badly flayed. These are only suitable for cheap, light sole butts. The Kerrys, however, often yield good butts. South American hides (usually salted or dry salted) are generally excellent, being carefully slaughtered, well flayed, thoroughly cleansed, and well cured. They possess, however, the very objectionable brand, which is often both large and deep. Central American flint hides are mostly used in the United States. Chicago packer hides are well salted and well flayed, but are not so thick, and are mostly employed for the manufacture of upper leather. Continental hides are generally salted and without horns and tail bones. Bavarians are among the best, being celebrated for their thickness, evenness of growth, tight texture, and fine smooth grain. They are very suitable for sole and belting leather. Swiss and Italian hides are also good, being compact in texture and well flayed. Scandinavian hides have also a well-deserved reputation. Hungarian hides are sometimes very large, but are tight in texture, well flayed, and give good grain. Hides from the lowlands of Germany, Holland, and France are long in shank and not so well grown. French hides are often very badly flayed. East India kips are very suitable for upper leathers.

The quality of sheepskins is influenced by the condition of the animal's life in much the same way as hides. Sheep exposed to the extremes of climate yield the best pelts, whilst those which are carefully bred for their wool are apt to give poor thin skins. The light-leather manufacturer generally obtains his sheepskins from the 'fellmonger', whose work it is to remove the wool from the pelt. Of the long-woolled breeds, the Leicesters and Lincolns yield big pelts of good grain, but are sometimes thin. The Cotswolds have very greasy pelts, especially in the back. Devons give a good *white* pelt, but somewhat smaller than those mentioned hitherto. Kents also yield good skins, but Roscommons are apt to be somewhat 'leggy'. Of the short-woolled breeds, the various pure and cross-bred Downs are of course the most important, and yield pelts of intermediate quality. The mountain breeds yield some of the best pelts. Cheviots, Blackfaces, Herdwicks, Limestones, and Lonks—all yield good skins. Exmoors and Dartmoors yield small tough pelts. The soft-woolled Mountain sheep give a very small pelt; Shetlands are good; and Welsh Mountain sheep are noted for their small fine-grained pelts. Sheepskins are also imported to a considerable extent from South America, Mexico, the Cape, Australia, and New Zealand, and of course are cured by one or other of the processes mentioned for hides. Some skins, however, are fellmongered and imported in a 'pickled' state (see later). Tanned skins are also largely imported from the East and dressed in this country.

The small skins are largely 'tawed' with alum and salt and dressed for shoe linings and glove leather. The Welsh Mountain sheep, however, are liked for roller leather. The medium-sized skins are tanned extensively for 'roans', whilst the large pelts are split in two, the 'grains' being tanned with vegetable materials for 'skivers', and the 'fleshes' being made into chamois leather by treating with oil. Skivers are used for hat linings, pocket-books, and fancy articles. A good number of large sheepskins are bark-tanned for 'basils',

some are tawed for aprons and white leather, and others are dressed with the wool still on and used for mats and rugs. Many sheepskins are now chrome-tanned and made into imitation glacé goat.

Goatskins yield a leather of superior texture and durability to that obtained from the sheep, and are extensively imported from all parts of the world. The Cape goatskins (dried) are large, thick, and strong, but not always perfectly sound. Abyssinian skins are exceedingly tough and compact, and yield a bold grain. Bavarian and Balkan skins are somewhat small, but plump and fine-grained. Mexicans have a high reputation, but Scandinavians are often poor. All these skins are largely tanned in this country for bookbinding and upholstery leathers. Indian dried goatskins are extensively imported for the manufacture of light chrome leathers (glacé kid, &c.). Kidskins are imported from Italy, France, and Ireland, and tawed for glove leathers.

The Wet Work.—This is a term applied to various processes preparatory to the tanning proper, which processes are also often spoken of as the 'beam-house work', and of which the most important are soaking, depilation, and deliming—the last including puering, bating, drenching, and pickling.

1. *Soaking*, the first process of leather manufacture, consists essentially in softening and cleansing the hides and skins by means of water. By inserting into water, most of the adhering blood, dung, and dirt may be softened and removed, and the pelt itself slightly swollen. Any dehydration of the skin, such as occurs in salting, drying, and dry salting, is also counteracted at this stage, and the removal of the salt is effected. All these objects are most efficiently brought about by a plentiful use of water, but the process must not be very prolonged or damage may be done by the commencement of putrefaction. The softening process is often materially assisted by the use of rotating cylindrical drums or by 'falling stocks', and the cleansing ensured by the use of running water. With dried and drysalted hides, which soften with some difficulty, it is now usual to employ solutions of caustic soda or sodium sulphide of about 0·1 per cent strength.

2. *Depilation* or unhairing, the next process, is usually brought about either by sweating or liming.

Sweating is undoubtedly the more ancient process, and is really a process of regulated putrefaction in which the hair root and epidermis is attacked before the corium is seriously affected. The action is stopped when the hair or wool is sufficiently loose to be removed easily by gentle mechanical treatment. The goods are hung up in closed chambers known as a 'sweat pit', and the temperature and humidity of the atmosphere is carefully controlled. The sweat pit is usually a stone structure, with a double wall lined with earth, timber, tan bark, &c., to assist in keeping the temperature constant. Air-tight doors, windows, and ventilators are provided, and also steam pipes to warm and moisten the air as required. In the 'cold sweat system', employed largely in the United States, the temperature is kept between 60° and 70° F., and the process lasts usually four to five days, but is somewhat longer in winter. In the 'warm sweat system', which is employed for both hides and sheepskins on the Continent, the temperature is generally 75° to 80° F., and the process is consequently somewhat quicker. Both these systems are liable to injure the goods through the bacterial action either going too far or being uneven, and a further disadvantage as compared with liming is that the natural grease of the skin is unattacked and unremoved. In the case of sheepskins, however, the wool is obtained in a better condition than in the case of limed goods.

Liming is the most widely used method of depilation in this country, at any rate for hides and goatskins. It consists in immersing the goods in pits containing milk of lime, occasionally assisted by sodium sulphide and other depilatants. In this case also the hair roots and softer keratins are dissolved, and the hair and epidermis therefore loosened. The caustic lime also swells and plumps the corium fibres, and splits up the fibre bundles into their constituent fibrils, and also saponifies and emulsifies the greasy matters of the skin,—both these actions assisting materially in hastening the tannage and making it more complete.

The unhairing action of lime liquors is undoubtedly due, at least partly, to bacterial action, especially in old and 'mellow' limes. Sodium sulphide (Na_2S, $9\,H_2O$) is now the principal assistant to lime, on account of its rapid solvent action on the keratinous matters of the epidermis and comparatively small effect on the gelatinous matters of the corium. It is best used in small quantities dissolved in the lime liquors, especially in the short-hair season. It is also used, however, in strong solution—with and without lime. In this case the goods may be inserted into a 30–40-per-cent solution, or the solution may be painted on the hair side of the hides. By either mode of procedure the whole of the hair and epidermis will be reduced to a pulp in a few hours.

These processes, however, have several disadvantages, the chief of which are the non-removal of hair roots, the non-saponification of grease, and the total loss of the hair. Solutions of sulphide of less strength and thickened with lime are employed with great success by fellmongers in unwoolling sheepskins. The creamy mixture is painted on the flesh side of the skin, and the hair root is thereby first attacked. The wool can then be pulled away quite uninjured. The open texture of the sheepskin and the deepness of the roots of its wool are perhaps reasons why this method of treatment is so efficient. It is usual to lime the pelts after removing the wool, in order to 'kill' the grease which is so plentiful in sheepskins. Arsenic sulphide (realgar, As_2S_2) is also another common assistant to lime. It is added to the lime whilst slaking, and the reaction which takes place gives rise to calcium sulphydrate ($Ca(SH)_2$), which together with lime acts as an efficient depilatant and is not so harsh as sodium sulphide.

The time taken in ordinary liming varies largely with the methods employed, but is generally from about a week to a fortnight, but occasionally up to three weeks. The heavier leathers (sole, harness, and belting leathers) receive the shorter liming, dressing leathers receive usually a mellower liming, and the light leathers the longest liming in order to obtain the requisite softness and pliability. After insertion in the 'limes' for the requisite time, the hides are laid over a sloping convex 'beam' and the loosened hair is scraped off by means of a blunt two-handled knife with a concave edge. Any superfluous fat or flesh is then cut off by a sharp two-handled knife, this operation also being over the beam. These operations are now often brought about by machinery.

3. *Deliming*, which is the next process in leather formation, involves usually more than the mere removal of the lime. For the light leathers there is desired the reduction of the swelling and plumping action of the limes, and a further bacterial action by which more hide substance is removed, and the desired softness thereby obtained in the finished article. These effects are usually accomplished by puering and drenching. *Puering* consists in immersing the goods for some hours in a warm fermenting infusion of dog dung, which removes the lime both by mechanical and chemical action, and causes also the solution of a certain amount of interfibrillar substance. The swelling is also brought down almost completely. In spite of many attempts to find a substitute for this disgusting process, there has none been discovered which is satisfactory for many classes of leather. *Drenching*, which follows, consists in steeping the goods in a fermenting infusion made by scalding bran with hot water. The fermentation involves the production of acids (lactic acid, acetic acid, &c.) which neutralize any lime in the skin and slightly plump the pelt. The gases produced have also a peculiar opening effect on the pelt, and the bran acts to some extent as a mechanical cleanser. For dressing leather (harness, bag, and upper leather, &c.) a much more moderate treatment is desired, and the goods are therefore generally *bated*. This is in principle very closely similar to puering, but hen and pigeon dung takes the place of dog dung, and the process is generally carried out at a lower temperature, though often for several days. Dressing leather is also sometimes drenched. For sole and heavy leathers all that is required is the mere neutralization of the lime on the grain, for it is desired to tan the pelt in as plump a condition as possible in order to obtain the requisite firmness and good 'weights'. Boric, lactic, and acetic acids are largely used for this purpose in dilute solution, and are often employed also as substitutes for bating, the goods being limed for a somewhat longer time. Many other acids and deliming agents have been suggested, but they are not much used. After deliming, goods are often worked over the beam again with a 'scudding' knife or slate to remove hair sheaths, pigment, and other dirt from the skin. The goods are now ready for the tannage proper.

Pickling is a process sometimes applied to pelt at this stage. Its aim in some cases is to preserve the skin for export, and it is then brought about by treating with salt and sulphuric acid. The acid alone would have a drastic swelling action, but the salt represses this and assists in isolating the fibres, so that a kind of tannage is produced. Such goods must be 'depickled' with salt and weak alkalis (borax, whitening, &c.) before vegetable tannage, or else tanned in salted liquors. In other cases pickling is preliminary to vegetable or chrome tannage, and consists then of inserting the goods into a solution of alum and salt, with or without the addition of sulphuric acid.

THE ACTUAL TANNAGE.—There are an enormous number of methods of tanning pelt to form leather, but those in common use may be readily classified into three divisions, vegetable tannages, mineral tannages, and oil tannages.

1. *Vegetable Tannages.* — Leather formation is in these cases the effect of immersing the pelt in aqueous infusions of the 'vegetable tanning materials', all of which contain appreciable quantities of 'tannin'—a general name for a class of soluble organic colloids of a phenolic character. These tanning materials are obtained from various parts of many plants. The barks of the oak, pine, hemlock fir, wattle (mimosa), birch, larch, mangrove, and mallet; the wood of the oak, chestnut, and quebracho (*Loxopterygium Lorenzii*); the leaves of sumach (*Rhus coriaria*), and the gambier shrub (*Nauclea Gambir*); the fruit of many trees, *e.g.* myrobalans (*Terminalia Chebula*), valonia (acorn cup of the Turkish oak), algarobilla and divi-divi (pods of *Cæsalpinia brevifolia* and *C. coriaria* respectively), and even the excrescences (galls and knoppern) of various species of oak — all are very valuable sources of tannin. Oak bark and gambier are the oldest tanning materials used in this country, but valonia and myrobalans are now the most widely used. All these materials give characteristic qualities to the leather they make, and hence it is necessary to choose tanning materials according to the effect desired, and to blend them one with the other in the proper proportions. Valonia, *e.g.*, would be chosen for weight and firmness, as in sole leather manufacture: gambier for softness and mellowness, as in dressing leather tannages; sumach for a light, even colour, as in the case of leathers that are to be dyed. The infusions are made by extracting the tanning materials with water in a series of vats or pits (leaching) in such a way that the water comes in contact with the nearly spent material. The infusions so prepared are known as the 'tan liquors'. Tanning 'extracts' are now manufactured on a large scale from nearly all materials, and sold in strong solutions or in solid form. They save the tanner the trouble of leaching, and make available materials which would otherwise be neglected.

In all vegetable tannages the most important maxim is that the goods should be placed in tan liquors of gradually increasing strength in tannin. This is done conveniently, economically, and scientifically by the almost universal system of 'working the liquors down the yard'.

By this method the goods are first inserted into old and nearly exhausted liquors, and afterwards into newer and 'fresher' liquors. The process is scientific, because the old liquors have had the more astringent tannins removed by repeated use, and contain only the 'mellow' tannins, which do not cause any harshness on the grain. The system is economical, because it permits the exhaustion of every tan liquor, and therefore practically no waste in tannin. The strength of the tan liquors is usually judged in practice by means of a special hydrometer called the 'barkometer'. The tannage is generally done in pits or vats for the heavier leathers, but generally in paddles for the light leathers. Sole, belting, and harness leathers are tanned in periods which vary in different tanyards from three to twelve months, dressing leather is tanned in two to six months, and light leathers in times varying from a few days up to a few weeks.

2. *Mineral tannages* are typified by the alum and chrome tannages. The former is effected by means of alum and salt, and has been practised for some centuries. Varying amounts of egg yolk or olive oil and of flour are used along with the alum and salt. The alum splits up into a basic salt which tans, and free acid which, together with the salt, produces a pickling effect; the egg yolk or oil coats and lubricates the fibres, and gives softness, fullness, and stretch; the flour acts as a whitening and filling agent, and assists also in the emulsification of the oil. This process of 'tawing' is still extensively used for the manufacture of 'glove kid', and was once largely employed for making 'calf kid'.

The chrome tannages, which are of comparatively modern introduction, are now of great commercial importance, and have seriously threatened the supremacy of many of the time-honoured processes of vegetable tanning. There are two kinds of chrome tannage, named respectively the 'one-bath process' and the 'two-bath process'. The one-bath process consists in employing solutions of a basic chromic salt, *e.g.* $Cr(OH)SO_4$. This is made either by adding soda to a chrome alum solution, or by reducing potassium dichromate with glucose in the presence of the theoretical quantity of sulphuric acid. The solutions so obtained are employed in a manner very closely similar to the vegetable tan liquors, the goods being inserted into chrome liquors of gradually increasing strength. The tannage is generally done in drums, but for the heaviest goods it is sometimes in pits, and for light goods in paddles. The time required for tanning varies from a few hours up to a few days, and is therefore very rapid as compared with the vegetable tannages. The two-bath process, as the name implies, involves the use of two distinct 'baths'. The first of these consists in treating the goods with a solution of chromic acid (CrO_3), made usually by adding hydrochloric acid to potassium dichromate. In some modifications (*e.g.* the original Schultz patent) there is an excess of dichromate, in others an excess of hydrochloric acid, and in the so-called 'neutral' bath there is an excess of neither reagent. Alum and salt are also often added to this first bath. In this 'chroming bath' the yellow chromic acid strikes through the pelt in about six hours, and the goods are then usually 'horsed up' overnight. The second bath consists of a solution of 'hypo' (sodium thiosulphate), acidified with hydrochloric acid, and this effects a reduction of the chromic acid to a basic chromic salt which tans the pelt. The acid is added somewhat gradually to the hypo bath until the reduction is complete, and the pelt when cut shows an even blue-green colour throughout. It is usual, however, to leave the goods in the second bath overnight. A certain amount of free sulphur is deposited in the leather by this process, and is said to cause the difference in 'mellowness' of the two types of tannage.

Both processes make equally good leather, and have been successfully employed for both light and heavy leathers. Calfskins and hides are now extensively chrome-tanned for 'box calf', 'willow calf', &c., and goat and sheep skins for 'glacé kid'.

3. *Oil tannages* are typified by the manufacture of chamois leather from sheepskin splits. These are sprinkled with cod oil or sometimes other marine oils, and then beaten for an hour or so in the 'faller stocks' or mill. They are then hung up for about a day to dry and oxidize. This treatment is continued until the goods are tanned. The stocking distributes the oil evenly over the goods, and causes the heating and oxidation of the oil. Some of the oxidation products (aldehydes, &c.) have the property of tanning pelt, and others (oxidized fatty acids, &c.), together with unchanged oil, coat the fibres, and make permanent the isolation of the fibres.

Similar processes with hides and deerskins give rise to 'buff' and 'buck' leather respectively. A similar product can also be obtained by the use of formaldehyde alone (Payne and Pullman patent). Helvetia and Crown leathers are made by placing the hides with a paste of soft fats and flour into rotating cylindrical drums. In this case there is little oxidation, but the fibres are dried in an isolated condition, and hence a 'leather' is obtained.

THE FINISHING PROCESSES.—These are of almost infinite variety, and consist largely of mechanical operations, the object of many of which is to produce an article of pleasing appearance. A very brief outline must suffice in describing this part of leather manufacture.

Sole leather after tannage is 'scoured' with stone, brush, and slicker, to remove superfluous tan and to give a smooth, clean grain. It is then carefully dried out, rolled, and brushed, being oiled on the grain to give good colour.

Dressing leather is finished by 'curriers', whose principal operation is 'stuffing' the leather with oils and fats in order to give pliability and waterproofness. Harness and belting leather usually take less grease than upper leather. Dressing hides are often 'split' into two pieces of equal area, which may then be finished in quite different ways. Except for belting, this class of leather is generally blacked or stained with dyestuffs.

Light leathers are usually dyed (*e.g.* moroccos for bookbinding and furniture work). This is generally brought about now by the artificial dyestuffs (coal-tar colours), but in the production of blacks the natural dyestuff 'logwood' is still extensively employed. After drying, seasoning, glazing, and graining, the goods are lightly oiled and dried out.

Chrome leathers are 'neutralized' with weak alkalis, and 'fat-liquored' with an emulsion of soap and oil. They are also dyed and finished in blacks and colours (*e.g.* box-calf, glacé kid, &c. The tawed leathers are dyed or stained, and given both dull and glossy finishes.

The oil-tanned leathers are freed from superfluous oil and often bleached, either by the action of the sun or of oxidizing agents.

It will be understood that only the principal methods of leather manufacture are outlined in this article, and that in 'combination tannages' and varying finishes there is almost infinite scope in producing leathers of different classes, according to the somewhat capricious demands of public taste. [H. G. B.]

Leather Jacket, the popular designation applied to the larvæ of the Crane Fly (*Tipula oleracea*), on account of its very tough skin. See arts. GRUB and TIPULA.

Leather Waste.—Leather waste ground up into a fine powder is frequently employed as a manure, and often forms one of the components of compound manures. See art. NITROGENOUS ORGANIC MANURES.

Leaven is fermented dough or yeast. Its use in breadmaking has been known from time immemorial. The primitive method consisted in making dough of flour and water, and leaving it to become sour before baking; a portion of the sour dough was then kept to mix with more fresh dough, thereby hastening the souring of the fresh dough. The sour dough or leaven contains a ferment which acts upon the starch in the flour, evolving carbon dioxide gas in the process. The evolution of the gas throughout the dough causes it to swell or rise, and gives to it a light spongy texture. Instead of leaving dough to undergo natural souring by chance ferments introduced from the atmosphere, in the making of leaven, yeast is used, which ferments starch more rapidly and with the same result. Besides carbon dioxide, some sugar, alcohol, and in old leaven, acids, ultimately appear. Unleavened or unfermented bread is solid and tenacious. It is still made in the passover cakes by the Jews; and in some parts of Australia by the settlers, and known as damper. [R. A. B.]

Lecanium, a genus of scale insects (Coccidæ). The best-known example is perhaps the Brown Currant Scale, *Lecanium coryli* (= *ribis*), which frequently attacks currant and gooseberry bushes. The winter eggs hatch out in February, and the young insects establish themselves on the twigs, forming glossy-brown hemispherical scales $\frac{1}{8}$ in. or more in diameter. In May and June the insects beneath the scales lay multitudes of eggs and then die, and in July these eggs hatch out to young scale insects, which wander over the plant and spread the disease. It is during this migration that dressings are most effectual. Judicious pruning and the destruction of the scales by the gloved hand are useful measures. Paraffin emulsions, in soft soap and sulphur washes, may be advantageously used at the beginning of February and in July.

There are many other species of Lecanium, among which may be mentioned *L. vitis*, which affects the vine, and *L. capreæ*, which attacks numerous garden trees, and which has sometimes been known to injure the apple. Some species are of frequent occurrence in hothouses. [C. W.]

Lecithin. See art. PROTEIN.

Led Farms.—A farm on which the owner or farmer does not reside, and which consequently has to be managed more or less by a deputy, is called a led farm. As arable and dairy farms require much personal supervision, there are not a great number of these kept as led farms; but sheep farms are very commonly held by farmers who do not live on them, or perhaps even near them. There are hundreds, if not thousands, of pastoral farms in the country on which there is no dwelling-house suitable for a farmer's family, and the shepherd's cottage is the only habitation. The *advantage* of the system of led farming is that the expense of management is reduced to a minimum. The shepherd's wage is the principal item; and as he will probably have two or three cows, whose food is grown on the farm, and other perquisites, the money paid to him is not very considerable. In former times, shepherds were remunerated entirely by having sheep of their own on the hill—called the pack, the produce of which were sold for their own benefit. This custom is now dying out, and almost all herds have a part of their wage at least in cash. The *disadvantage* of led farming is the difficulty the farmer has in giving the personal supervision and attention he may wish to devote to his place. Shepherds, however, can happily still be got who are faithful, capable, and trustworthy, who make their employer's interests their own, and who settle during the whole of the lease, probably for successive leases, without a thought of change of home or employer. This fact makes the personal attention of the farmer the less necessary, although even with the best of servants the most satisfactory results are got when the master shows a keen personal interest in every detail.

Not a few lowland farmers have led farms in the north of Scotland, and these they can only visit at most probably twice or thrice each year. All farmers like to be present at the 'marking' of their lambs, when they get from the shepherds the numbers of the recent additions to their live stock. The clipping in July, and the 'speaning' or 'weaning' of the lambs in August, will be the occasions of later visits; and if the distance be not too great the farmer will also wish to be present in the early days of October, when the old and shot ewes are drawn off for market, and the winter stock of the farm is made up. The writer, however, has known an instance of a farmer who did not visit his holding once in fifteen years, contenting himself with sending his shepherd a short note now

and again, when the times for selling the lambs and the ewes came round. On many led farms a considerable proportion of the shepherd's time is taken up with securing peats for his winter fuel, and hay for his cows, but all good men have as their motto—and they never forget it —'the sheep first'. They are totally regardless of the number of hours per day they work; and if during part of the year they seem to have but little to do, it must be remembered that from April to October they have probably been walking or working, Sunday and weekday, from daylight till dark. [W. B.]

Leeches (Hirudinea or Discophora), a class of wormlike animals, usually distinguished by having a posterior adhesive sucker in addition to the suctorial mouth, by the absence of bristles, and by the numerous superficial rings. Most leeches occur in fresh water, such as the common medicinal leech (*Hirudo medicinalis*), and the horse leech (Hæmopis or Aulastomum); some are terrestrial, such as the land leech Trocheta; a few are marine, such as Pontobdella, the skate sucker. The medicinal leech, already named, was once indispensable to the physician (often called the 'leech'); it has three jaw-plates in its mouth, each with about ninety minute teeth, and gives a neat triradiate bite. Various other leeches are or have been used for blood-letting. Land leeches, such as Hæmadipsa, are sometimes troublesome in the Tropics, both to man and domestic animals; they adhere to the skin, and some of the small ones are able to insinuate themselves under clothes. In some cases, notably *Limnatis nilotica* of N. Africa, the leech is taken in with drinking water. It may settle about the pharynx of men and horses, and give rise to serious trouble. [J. A. T.]

Leek (*Allium Porrum*, nat. ord. Liliaceæ), a hardy biennial of very old cultivation in this country. Although the national emblem of Wales, it is not known in a wild state, and is considered to be a cultivated variety of the native *A. Ampeloprasum*. Leeks are especially esteemed in Scotland, and Musselburgh (from whence many of the best varieties have originated) is a great centre for their cultivation. They are very hardy plants, and this is probably the reason why they are more esteemed in the north than in the south. Although this vegetable will grow under the most unfavourable conditions, it is responsive to liberal cultivation, and for the production of large, tender, and fine-flavoured plants a rich light soil, with plenty of water in dry weather, is required. In small gardens one sowing, made in March, is generally made to suffice, and from this a successional supply can be obtained by transplanting the most forward seedlings from time to time as they become ready. They should be transferred to thoroughly prepared ground at distances from 6 in. to 1 ft. apart, and, unless the soil is moist at the time, the ground must be well watered previously. They are sometimes planted in trenches, as with celery, and in damp places transplanting less deeply than is usual and afterwards drawing up earth to the stems is a good alternative method.

Leeks will stand through the winter out-of-doors; but some growers take them up and store them in sand, in which condition they will keep for a time. They are not generally forced; but sometimes in France they are had early by the expedient of a hotbed, the variety Yellow Poitou being preferred for cultivation in this way. Large Rouen, London Flag, Musselburgh, and the Lyon are some of the very best kinds. [W. W.]

Leghorn Fowl.—This is one of the most valuable of present-day races of poultry; in fact in America and Denmark, as well as in England, it has proved to be the most useful race for egg production. It was imported into

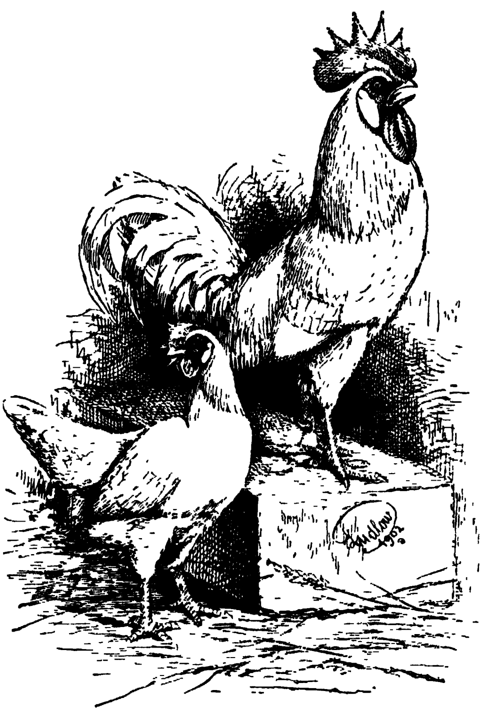


Fig. 1.—White Leghorns

America from Italy, where this type of fowl is very general, and came to Britain through America. At that time there were only two varieties, the Whites and Browns, although Blacks are found in Tuscany. From these have been evolved several other varieties, and now we have altogether eight, namely, Whites, Browns, Blacks, Buffs, Cuckoos, Piles, Duckwings, and Mottled. They are non-sitters, very prolific as egg producers, hardy, and able to withstand almost any conditions; but the flesh qualities are only very mediocre, and as the legs and flesh are yellow these birds do not conform to market requirements. The great point in their favour is their remarkable vigour; and in the more exposed parts of the country they are very popular indeed from the fact that as egg producers they have no superior, although they require to be specially bred for winter laying. In size of body they are, or should be, somewhat on the small side, not exceeding in males 5½ to

7 lb., and in females $4\frac{1}{2}$ to $5\frac{1}{2}$ lb.; in fact the better layers are those that are less than the weights named. A mistake has been made in increasing the size of body, which, more especially in the White variety, has been carried to a very great excess by exhibitors within the last few years. Practical poultry keepers should avoid the modern type of White Leghorn, and in preference to that secure specimens of the older and more correct type. The birds partake of what is known as the Mediterranean shape, that is, a somewhat long body, well developed behind, with legs of medium length, and a single comb, which falls over in the hen, and longish wattles. The body is well covered with feathers. They are bright and active, excellent foragers,

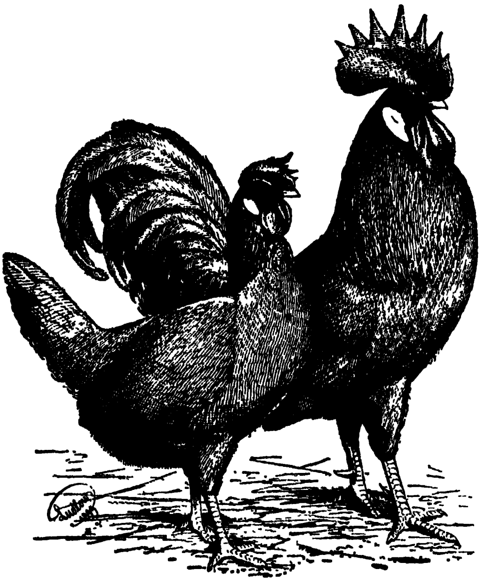


Fig. 2.—Buff Leghorns

and comparatively small eaters. Equally in America, Britain, and Denmark these birds have proved amongst the very best layers, and, in the two last named countries especially, a great deal has been done to develop this quality. The Danes, by careful selection, have improved this breed not only in regard to the number of eggs laid, but also in the size of the eggs. For practical purposes the Whites, the Browns, and the Blacks should be preferred. [E. B.]

Legislation, Agricultural.—Some of the epoch-marking statutes affecting agriculture are referred to in AGRICULTURE, TENANT RIGHT, and articles on individual Acts. Among the modern measures which farmers value most highly are the Acts for the eradication or prevention of diseases of animals, the Agricultural Holdings Acts, the Agricultural Rates Act, the several measures for preventing the sale of adulterated farm produce as genuine, the statutes alleviating the harshness and restrictions of the Game Laws, and the Acts relating to the sale of fertilizers and feedingstuffs. But the efficacy of agricultural as of other branches of legislation has invariably been impaired by the inveterate habit of compromise characteristic of the people of this country, or by undue consideration for vested interests even when they are forms of fraud. The history of cattle-disease legislation affords one illustration of the former fault. It began with half measures which inflicted a maximum of inconvenience and involved a heavy annual expenditure for a long period, for the sake of a minimum of beneficial results; and even after the suppression of rinderpest, foot-and-mouth disease, and pleuropneumonia had demonstrated the true economy of the stamping-out process, our legislators had not the courage to apply it to other contagious or infectious diseases. Therefore the nation has been mulcted in heavy charges annually, and stock-keepers have had to suffer permanent inconvenience and loss from restrictions, with no better result than fluctuations in the number of outbreaks of certain diseases in different years. A flagrant illustration of the folly of this course of action is to be seen in the costly and harassing interference with the pig traffic involved in the futile attempts to check swine fever. No truth has been more conclusively demonstrated in reference to diseases of this type, than that of the real economy in the long run of expense and inconvenience secured by the stamping-out process, however costly and inconvenient it may be for the short period covered by it. Probably the country has spent on meddling and muddling in relation to swine fever ten times as much since the Act of 1897 was passed, as it would have had to pay for the total suppression of the disease. As to tuberculosis, it has not yet been even included in the list of diseases of animals placed under the charge of the Board of Agriculture, and all that is officially done in relation to the disease is the infliction of loss and inconvenience in connection with the meat and milk supply.

As for other illustrations of the inveterate habit of compromise, it may be observed in passing that the Agricultural Rates Act is merely a partial makeshift for the readjustment of local taxation promised by several governments for about half a century, and that the article on TENANT RIGHT shows in some detail the slowness of the advance by meagre instalments of provisions of bare justice to tenant farmers. Similarly in the legislation for preventing the defrauding of consumers and unfair competition with sellers of genuine articles, embodied in the several Food and Drugs Acts, efficiency was sacrificed time after time to undue consideration for interests not entitled to indulgence; and even in one of the latest of these measures, the Sale of Butter Act, our legislators made a special exception to the general rule as to the maximum quantity of water to be allowed in butter or margarine, for the express purpose of legalizing the sale of milk-blended butter, a commodity made with the distinct object of selling water to consumers at the price of butter. Lastly, in connection with this point of the subject, the new Fertilizers and Feedingstuffs Act, while aiming ostensibly

at the prevention of fraud and deception in sales to farmers, smothers the operative sections in such a mass of formalities, and affords to dishonest vendors so many loopholes of escape, that it will be a wonder if many of even the worst offenders meet with their deserved punishment.

Perhaps the greatest failure in legislation largely agricultural is to be found in the Railway and Canal Traffic Act. This measure was the outcome of an agitation started in an agricultural paper, and maintained by the Chambers of Agriculture and other associations. Great advantages were expected from it; but the results were entirely disappointing. After the passing of the measure, railway rates and charges were raised instead of being lowered, while preference rates on imported goods, which the Act seemed to prohibit in absolute terms, were in no way touched. Of this, as of some other measures, however, it may be said that the intentions of Parliament have been frustrated by judgments in the Courts of Law, which in their turn have been due to the bad drafting or insufficient explicitness of certain sections of the Acts. A notable example is that of the complete nullification by the Law Courts of a section of the Market Gardeners Act beyond all question intended to be retrospective, but so badly worded that the judges in a test case decided that it had no reference to planting and other improvements carried out before the passing of the Act.

For farm labourers, apart from compulsory and free education for their children, which too many of them fail to appreciate properly, the most beneficial Acts are those relating to small holdings, allotments, and pensions. [W. E. B.]

Legs, Swelling of.—Swelled legs in animals have not, as a rule, the serious significance of similar dropsical effusions in the human subject. There are no muscles below the knees and hocks, and animals (especially horses) spend much time on their feet, which is unfavourable to the return of blood through the veins. The escape of the watery portion of the blood through the walls of the vessels is quite common in debilitated animals, and these accumulations, which give rise to swelling, are usually absorbed rapidly as a result of exercise. They seldom imply heart disease or any of those serious affections which give rise to swelled legs in men. Swellings of the simple character which will be in the minds of the majority of readers are found to pit on pressure of the fingers, and to fill out again while watched; and these being due in most cases to want of tone or vigour, are cured by tonics and diuretics, combined with improved diet, or increased quantity of food. Permanent swellings of the legs result from attacks of lymphangitis, weed, or Monday morning leg, from grease, strains, and chronic inflammation, and are considered under these various headings. Bandaging the lower portions of the limbs has the effect of preventing those swellings which are due to simple effusion of fluid from the vessels. [H. L.]

Leguminosæ is the botanical name for a natural order of dicotyledonous plants with perigynous flowers. The term 'perigynous' means, in this case, that the end of the flower-stalk spreads out in the form of a disk (torus), and that the sepals, petals, and stamens are attached to the margin of this disk as shown in the diagram. The representatives of this order grown in Britain belong to the sub-order called Papilionaceæ, and are distinguished by the following characters:—

1. The petals are five in number, so arranged that the upper petal (standard) overlaps the two side petals (wings), and the side petals in turn overlap the two lowest petals (keel), which are grown together.

Fig. 1.—Vertical Section of a Papilionaceous Flower

2. The stamens are ten in number, and are not free from one another, but grown together by their filaments (monadelphous), *e.g.* Broom; or the upper filament is free from the other nine (diadelphous), *e.g.* Pea.

3. The single carpel of the flower ripens into a dry fruit which opens longitudinally by two valves, and is called legume fruit.

Much attention has been paid to leguminous plants, on account of the presence in their roots of an organism which has the power of utilizing the elementary nitrogen taken from the air in the soil around the root. Nitrogen as an element is useless to the plant, but the organism in the root changes the element nitrogen into a nitrogenous compound which the leguminous plant uses for building up its foodstuffs and its body. This peculiarity enables the leguminous plant to dispense more or less with ready-made nitrogenous compounds, such as nitrate of soda and sulphate of ammonia. Because of this power of utilizing elementary nitrogen, Leguminosæ can thrive on poor barren soils unsuited for other crops which cannot live without supplies of ready-made nitrogenous compounds. The special organisms for manufacturing the compounds of nitrogen are not spread over the whole root, but are confined to certain wart-like excrescences (thickenings of the cortex) called *nodules*. Cultures of the organisms suited to each kind of leguminous plant can now be purchased, and applied by the farmer to the seed or to the land. We can now see that a leguminous crop will leave the land richer in nitrogenous compounds, and with this in view farmers sow clover, lucerne, lupine, &c.

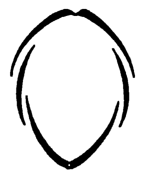


Fig. 2.—Arrangement of Petals in Papilionaceæ

The genera of Leguminosæ common on farms may be classified and distinguished thus:—

1. The leaf is pinnate, and ends in a tendril.

Vetches (Vicia).—Style threadlike.
Everlasting Pea (Lathyrus).—Style flat, the leaflets specially large.

2. The leaf is pinnate, and ends in a prong.

Bean.—Style threadlike.

3. The leaf is compound-pinnate, and ends in a single leaflet.

Serradella (Ornithopus).—The fruit is not a legume but a lomentum, which splits transversely into one-seeded joints.

Sainfoin (Onobrychis).—The fruit is not a legume but a one-seeded nut.

Bird's-foot Trefoil (Lotus).—Five leaflets per leaf; the fruit is a legume.

Kidney Vetch.—Calyx downy and inflated; the ground leaf has a simple blade.

Liquorice (Glycyrrhiza). — Extensively creeping underground stem with sweet taste; flowers pale blue.

4. The leaf is composed of three leaflets (trifoliate).

Clovers (Trifolium). — Flowers in a head; the withered corolla persists round the fruit.

Lucerne and *Trefoil* (Medicago).—Flowers in a head; the corolla falls away, leaving the fruit bare.

Bokhara Clover (Melilotus). — Flowers in a raceme.

Rest Harrow (Ononis).—Stamens all grown together by their filaments (monadelphous).

Broom (Sarothamnus).—Leaf sometimes simple, but never with a hard sharp point.

5. The leaf is simple, with a hard sharp point (leaf spine).

Whin or Gorse (Ulex).—The branch stems have hard sharp points.

6. The leaf is composed of more than three leaflets springing from a point (digitate leaf).

Lupine (Lupinus).

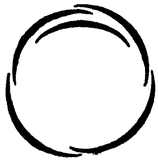


Fig. 3.—Arrangement of Petals in Cæsalpiniaceæ

The two sub-orders of Leguminosæ not represented in the British flora are: (1) Mimosaceæ, with the petals not overlapping, but fitting into one another like valves; (2) Cæsalpiniaceæ, with the petals so arranged that the two lowest overlap the two side petals, and the two side petals in turn overlap the uppermost petal.

Important plants belonging to the sub-order Mimosaceæ are:—

Sensitive Plant (*Mimosa pudica*). — A common weed in Jamaica and throughout the Tropics.

Acacias.—Various species abound in Australian forests. The leaf is characteristic, for the blade has partially or entirely disappeared and the petiole has become a vertically flattened plate called *phyllode*. Some species are valuable for gum, and some for tannin. Gum acacia exudes from wounds in the stem of *Acacia Senegal*, which grows in the Soudan. Catechu tannin is obtained from *Acacia Catechu*, a tree of the East Indies.

Important plants belonging to the sub-order Cæsalpiniaceæ are:—

Senna (*Cassia angustifolia*).—The dried leaflets of this shrub are the senna of the drug shops.

Tamarind (*Tamarindus indica*) is a fruit-bearing tropical tree.

Logwood (*Hæmatoxylon campechianum*). — The heartwood of this tropical American tree is the logwood of commerce.

In dealing with leguminous plants it must not be forgotten that the seeds are often poisonous. This is the case, for example, with Laburnum, and with species of Everlasting Pea which come from India, sometimes labelled 'gram'. The Ordeal Bean of Old Calabar is a well-known poison produced by a great twining leguminous plant. The natives used to compel suspected persons to eat of this bean till they vomited or died. Vomiting was considered a proof of innocence, and death a proof of guilt.

[A. N. M'A.]

Leicester Cheese.—Leicester cheese, when of high quality, is in the front rank of British varieties. Although it is coloured with annatto, which is a great mistake, it is, when good, rich, mellow, and almost of butter-like consistence, and presents to the palate a fine, nutty flavour. But for reasons which are best known to makers, its quality is far inferior to what it was, if we may judge by the samples which are exhibited at shows. A Leicester cheese is about 18 to 20 in. in diameter, by 5 in. in thickness, and although it is probable that in some instances the milk is skimmed before the production of the cheese, it is essentially a variety made from whole milk. No common system is employed in making the Leicester cheese, as is the case with some other leading varieties, especially as regards the temperature of the milk when the rennet is added and a quantity of salt employed. It would be well if those interested in the manufacture of this cheese were induced to take some steps to place it upon a substantial basis, to revive its popularity, and to devise some common system such as was employed twenty years ago by makers of the finest samples. During the warmer weather of summer the milk is set at 78° F., while in the cooler weather of spring and autumn it is increased to 82° F., sufficient rennet being added to produce coagulation in sixty minutes. The curd is cut in the vat when ready for the knife, and subsequently stirred with great care, to prevent the removal of the fat and the consequent enrichment of the whey, for about twenty minutes, when it is allowed to settle at the bottom of the vat; the whey is then run off by a tap at the bottom where modern vats are used, and the curd is subsequently collected and placed in a clean cheese-cloth, in which it is slightly pressed with a weight until it is ready for mixing and salting. The quantity of salt added is at the rate of about 3 oz. to the curd produced from 40 gal. of milk; in some instances a smaller, and in others a slightly larger, quantity is used. When the curd is fairly dry and made ready for the press, it is placed beneath it and allowed to remain some hours; it is then removed, clothed in a clean dry cloth, and pressed again. About the same hour on the following day that the curd was put to press, the young cheese is removed and salted on the crust on every side with dry salt, which is rubbed gently in by hand. Salting in this manner is continued daily for several days, when the cheese is washed with warm water and placed in the curing room to dry and ripen, shelves being made for the purpose.

LEGUMINOSÆ

A. Sainfoin.
    1. Single flower.
B. Kidney Vetch.
    1. Single flower.
C. Bird's-foot Trefoil.
    1. Single flower.
D. Lucerne.
    1. Single flower.

Great care is essential, for the cheeses should be at first turned daily, and subsequently at shorter periods, until they are ripened for the market. The highest class of cheese is ripe in eight to nine months, but we have tasted many first-rate samples at the London Dairy Show in October which were made in early summer, and they have been as perfect as a Leicester cheese can be. Some makers, however, keep their cheeses from nine to twelve months, believing, as many others do, that they improve by keeping longer than what we may be inclined to term the statutory period. [J. Lo.]

Leicester Pigs obtained considerable preeminence in the time of Bakewell, who was not content with the improvement of sheep, cattle, and horses, but also turned his attention to the useful pig, which had in times past occupied a somewhat important position, when large areas in the county of Leicester and other adjoining counties were forest. At this period the native pig was of a dark-chestnut or mahogany colour, which gradually became of a grey rusty-black as the pigs grew old. The manner in which these pigs obtained their food, which consisted mainly of mast, acorns, and the roots of plants; the continual battles between the males in the early spring, and the necessity for fleetness when pursued by man or wild animals, developed that curious formation which is not entirely lost at the present time in the native and unimproved pig. The long lean snout, the short and pricked ears, not unlike the lugs of a fox, the heavy shoulders well protected by a thick hard shield, the fine bone, and the light, drooping hind quarters, were all the result of that fight for existence which was the lot of the forest pig. Although continuous and comparatively successful efforts have been made to improve the native pigs of Leicestershire, they are still capable of further improvement. The rusty-red or mahogany-coloured pig has been crossed with the Large and Middle White boar, resulting in the colour being rendered of a much lighter shade, the shoulders less heavy, the hind quarters better developed, the snout shortened, and the carcass altogether of a type more suitable for the butcher or bacon-curer. In the southern portion of the county, boars of a black colour were introduced, and a decided improvement followed—the pigs came of various colours, including black, sandy, and white. The sows were prolific and good sucklers, although somewhat shy, and the pigs fattened readily when nine to twelve months old, and furnished a good carcass of pork. The Leicestershire pigs of the present time are of much the same mixed type and character. [S. S.]

Leicester Sheep.—Robert Bakewell, whose name will for ever be associated with the advancement of the sheep-breeding industry, saw the day was coming when mutton would be of more value than wool. Before his day no true standard of shape was recognized. He discovered the principle of selection, and only used those rams and ewes that possessed the qualities which he wished to reproduce. Bakewell began his useful and far-reaching work about the year 1755, at Dishley, near Loughborough, in Leicestershire; and Professor Low condenses into a few words the full meaning of what this genius accomplished: 'The formation of the new Leicester breed of sheep may be said to form an epoch in the economical history of the domestic animals, and may well confer distinction on the individual who had the talent to conceive, and the fortitude to perfect, the design. The result was not only the creation of a breed by art, but the establishment of principles which are of universal application in the production of animals for human food.'

Bakewell being of a secretive temperament, divulged nothing of his methods. What may be called the original Leicester was of the same general type as the Teeswater, the Lincoln, and the Romney Marsh or Kent sheep; and if we compare the Kent sheep of the present day with the Leicester as it is now bred, a striking similarity will be observed. There is the same bold, intelligent head, well-developed fore quarters, and good legs. The Lincoln also has much in common with the pure Leicester, but more on this latter point may be reserved for further reference. The old Leicester was the foundation stock on which Bakewell built up the Improved or Dishley Leicester. The old style were heavy, coarse-grained sheep, having little flavour and no delicacy, the carcass being long and thin, flat-sided, and with large bones, and set on thick, rough legs; the sheep which were slow feeders were sent to market at two to three years old, and weighed up to 120 lb. apiece. The fleece was heavy and long, and coarse in quality. Bakewell's objective was to reduce the bone and offal, to obtain symmetry in the carcass, to improve the mutton, and also to increase the sheep's aptitude to fatten — in other words, to ensure early maturity. He practically ignored the fleece, which until then had always been regarded as the foremost object of the flockmaster's endeavour, and set himself to produce a sheep that would give a large quantity of fat mutton. Bakewell knew his market, and he bred accordingly. Mutton at that time could not be too fat. We are old enough to remember the days of abnormally fat mutton, for which the demand was greatest in the manufacturing centres where the people were great mutton fanciers.

Bakewell pursued his art with such success that in 1786 he made 1000 gs. by the letting of his rams. The year following he realized 1200 gs. by letting three of his rams, and 2000 gs. for seven others, and 3000 gs. in addition by letting the remainder of the rams to members of the newly formed Dishley Society. Thus within about thirty years of the beginning of his experiment he let his 'Dishley' rams in one season for 6200 gs.

The rules of this new (and the first) sheep society were drawn up on highly protective lines. No member was to hire or use a ram not belonging to Mr. Bakewell or to one of the members; no member was to let more than thirty rams in one season; and Mr. Bakewell himself engaged not to let any ram for less than 50 gs. to any person residing within 100 miles of Dishley. Undoubtedly he raised the new

Leicester to the highest pitch of perfection; but this was not all, for he was the creator of a new type of sheep. It was this breed which proved instrumental in improving all the long-wool breeds. Mr. Nicholson, R.S.A., painted a typical new Leicester in 1841, and in this it may be observed that the signs of good breeding are more marked than in those of any other breed of the time. A Lincoln sheep, painted also by the same artist in the same year, shows the Old Lincoln sheep, which was then a breed of great size but slow to mature; it had a fleece of long unctuous wool, which the mating with the Leicester further improved. The Leicester may not be so prolific even at the present day as are some breeds. This was too much overlooked in the time of Bakewell and his immediate followers. Their object was to produce a lamb that could be forced on so as to be ready at the earliest possible period for the purposes of breeding or of slaughter, and therefore the production of twins was not only unsought, but was regarded as an evil. It was considered that during the period of gestation few ewes would be able to bring to their full fœtal growth two such lambs as the Leicestershire breeders desired to have. The fact also soon began to be evident, that when the energies of the system were systematically directed to one point — the accumulation of flesh and fat as early and to as great an extent as possible—there must be a deficiency in some other point; and the Leicester tups were not such sure lamb-getters, the ewes were not so well disposed for impregnation, and the secretion of milk was not so abundant as in other breeds. When, however, the contest for the highest character as a tup-breeder, and the highest price for the letting of tups, somewhat abated, and the Leicesters were submitted to the usual routine of sheep husbandry, they became better breeders and better nurses. It was likewise, and not without reason, objected that Leicester lambs were tender and weakly, and unable to bear the occasional inclemency of the lambing season. This also was a consequence of the delicacy of form, and delicacy of constitution too, which were so sedulously cultivated in the 'New' Leicester sheep. Their indisposition to accumulate fat internally was, however, much in their favour. Had they 'died as well', or, in plainer language, contained as much fat as their external appearance bespoke, there would have been no room for the growth of the little one, and its puny form could not have endured the slightest hardship. The last objection to the new Leicester was the neglect and deficiency of its fleece. The weight and quality of the fleece were not merely, as they should be, somewhat secondary considerations, but they were comparatively disregarded. There is no such cause for complaint now—the wool is of considerably increased length, and has improved both in fineness and strength of fibre.

The principal value of the new Leicester consisted in the improvement which it effected when mated with other breeds of sheep. The experiment of crossing the South Down with the Leicester proved a success, resulting in the production of a carcass not materially diminished in value, and of a fleece of longer staple and nearly double the previous weight. In Cornwall the new blood was introduced with decided advantage, not only in improving the sheep that were obtained from Dartmoor and Exmoor, but in imparting a better fleece and carcass to the native breeds on the downs and heaths of the farther extremity of the county. In Somersetshire their influence may be traced in the Bamptons. In the county of Worcester the Leicester sheep was also introduced profitably; it penetrated even into the farthest extremity of South Wales; in the northern part of the Principality pure Leicesters were kept by some farmers, but they did not answer so well as crosses of them with the native breed. In Lancashire, Westmorland, and Cumberland the native short-woolled sheep were crossed with much benefit. It was questionable whether the Blackfaced and the Cheviot breeds would be benefited by crossing with the Leicester; and on this point Sir John Sinclair recorded his opinion as follows: 'The Dishley breed is perhaps the best ever reared for a rich arable district; but the least tincture of this blood is destructive to the mountain sheep, as it makes them incapable of standing the least scarcity of food'. Experience, however, proved that both the highland and upland sheep were capable of much improvement by admixture with lowland blood; they obtained the faculty of turning every particle of food to nutriment, and the early maturity, which constitute the value of the Leicester breed. We might go on multiplying instances of the value of the Leicester as a sheep used for the improvement of others; but on this point the words of Professor Wrightson, in his book entitled Sheep: Breeds and Management, may aptly be quoted: 'No race', he says, 'has been so largely employed as a means of improvement, and South Downs, Cotswolds, Lincolns, Shropshires, Hampshire Downs, and probably every sort of sheep, directly or indirectly, has benefited by it'. Again, the professor says: 'The new or improved Lincoln is the product of the Leicester crosses upon the old Lincoln'.

The Leicesters bore a prominent part in the improvement of the fleece of established breeds in the early period of the British Australian settlements. The first sheep were obtained from Bengal. Importations of the Leicesters and South Downs followed, and by means of crosses with them the fleeces of the Australian sheep were rendered almost as good and as valuable as the fleeces of those two breeds were in England. The sheep that first inhabited the North American settlements were of the old Leicester breed. Sheep of the improved Dishley breed were not long in finding their way across the Atlantic. The Merinos soon followed them, but at the present moment the Leicesters are acknowledged as the most widely diffused and most valuable breed (see American Leicester Record). Mr. Richard Gibson, of Delaware, Ontario, in vol. ii. of the Record (which answers to our English flock books), says 'the Leicester is the only English breed of sheep which has been improved upon in America'.

Photo. G. H. Parsons

LEICESTER SHEARLING RAM

WINNER OF FIRST PRIZE, R.A.S.E. SHOW, 1906

(7) Photo G. H. Parsons

LEICESTER EWE "MIDDLEWICK" (in full fleece)

WINNER OF FIVE FIRST PRIZES

Mr. Henry Stewart, in the same volume, says: 'The modern Leicester is a model sheep, a subject for the naturalist and artist to admire, and for the shepherd to make his money out of, and has been used in the refinement of almost every other modern breed'. In a test conducted by Professor Curtis at the Iowa Agricultural College Experiment Station at Ames, Iowa, 'the Leicesters stood right at the front of all the mutton breeds in the test in almost all points, and the lot were selected from seven Leicester breeders' flocks in Canada. In the cost of food consumed per pound of gain, they were among the cheapest, they made the largest weight for age when marketed. When slaughtered they gave the largest percentage of dressed carcass to live weight; on the block test their carcasses brought the most money for the producer, their wool sold for one cent more per pound than any other. The Leicester sheep', the reporter continues, 'needs only to be known to be appreciated and retained as the standard friend of the farmer and stockman.'

Bakewell was often, it is said, taken to task by inquisitive neighbours on account of his departure from the hitherto recognized procedure in the breeding of sheep. To one of these detractors, who objected that his mutton was too fat, he replied: 'I do not breed mutton for gentlemen, but for the public; and even my mutton may be kept leaner to suit every palate by stocking harder in proportion, and by killing the sheep at an earlier stage of their growth'. His success as a sheep-breeder is best indicated, as we have already pointed out, by the appreciation in which his flock was held. The Leicester cross produced, and still produces, a wonderful carcass, and a leg of this mutton is unsurpassed for sweetness and 'short' eating. Their great merit is early development and accumulation of weight on a comparatively small quantity of food; while among the long-woolled breeds there is none that can be so confidently relied on for purposes of improvement. An expert has said: 'There is no gainsaying the fact that as a lowland sheep the Leicester is without a rival, with its fullness of form, its great weight and mass of white wool'. To this laudation may be added, that the Leicester holds premier position on the wold lands of Yorkshire, where a typical flock of ewes may be seen on nearly every farm; to-day the breed stands, perhaps, unrivalled for its physique and rapid-maturing properties—a great desideratum in these days when animals, to yield the greatest profit, are marketed at the earliest possible moment. The Leicester, as now bred, has a good proportion of lean flesh. There has, of late years, been a reaction in favour of the breed. Many farmers who had been wedded to the Leicester, and who turned aside, 'for fancy', to try other breeds, are invariably almost returning to their old friends for fresh blood; and hence it follows that the farmers who have stuck to ram-breeding through good seasons and bad are now finding each season a ready market. Practical experience has proved that on the Yorkshire wolds, and in the adjoining vales, the produce of the Leicester, from a financial point of view, can compete successfully with every other breed, and that is a consideration which no practical farmer can afford to lose sight of. Writing in the Live Stock Journal of Sept. 4, 1903, Mr. E. Turnbull said: 'On the Yorkshire wolds and in the vales of York and Pickering, the Leicester continues to hold the field. The proportion of lean flesh is now much larger than in Sir Tatton Sykes's day.' Rams of this breed are regularly exported to New Zealand, Australia, South America, and France; and consignments have gone to Russia and Spain. In New Zealand, the Leicester is greatly favoured. Most excellent reports have from time to time been received of the stud sheep exported by members of the Leicester Sheep-breeders' Association. The winner of first prize at the 'Royal' in 1897 went to New Zealand, to the order of Mr. Russell, of Otipua, Timaru; and Mr. Brydon, his manager, wrote the late Mr. J. J. Simpson, of Hunmanby, in June of the following year, that the ram arrived out in first-class order, and he had had a good season out of him. 'I gave your ram', he says, 'forty-nine ewes, and have very few come back.' The ram was named by the purchaser England's Champion, and Mr. Brydon added: 'Every person who has seen him says he is the best ram of the breed that was ever seen in this country'. Mr. Joseph Barugh, of Wartle, Hamilton, N.Z., in an article on the Sheep-breeding Industry of Waikato Province, says: 'Border Leicesters are almost unknown here, and English Leicesters are very little used by small farmers; though some of the large estates and companies use them extensively, with most satisfactory results. I cannot understand why this breed of sheep is not more sought after by the smaller man, as the Lincoln and English Leicester blend well together, the Leicester giving the compact carcass, while the wools are of much the same nature, that a cross seems to be beneficial to both, without materially altering the class of wool.'

The Leicester sheep, then, has a sufficiently interesting history to command attention. What the South Down has done for the short-woolled breeds, the Leicester has accomplished for the breeds of long-wools. The Leicester improved the quality of the wool of other long-wool types of sheep, and imparted finer quality and earlier maturing properties to them. In some breeds, in which the Leicester had an important share in developing, it is necessary occasionally to infuse a fresh strain of Leicester blood to keep them up to the type required. With regard to the early maturity of this breed, the Yorkshire Post of December 24, 1895, quoted an instance of a pure-bred lamb in Flock No. 2 (the late Mr. J. J. Simpson's) whose carcass weight was 102 lb. The same issue of the paper also stated that the aged ram Barmston (Flock No. 1, Mr. Robinson's), exhibited at the Driffield Agricultural Show of 1894, weighed 472 lb. A shearling in No. 23 Flock (Mr. Joseph Thompson's) scaled 336 lb. That the Leicesters are also well fleeced is proved by the following facts: 57 shearling sheep of No. 2 Flock (Simpson's) were shorn in April, 1895, and a record

of the clips states that 9 gimmers yielded 16 lb. of wool each; 40 shearling rams clipped 17 lb. each; and 8 shearling rams produced 19 lb. each.

The writer has before him an interesting scrap of paper, written by a farmer who lived at Carnaby, in the East Riding of Yorkshire, and who began as a breeder of Leicester sheep in the year 1795, from ewes which were given to him by his father, who had possessed a flock of Leicesters from the time of Bakewell. This Mr. Robinson (whose flock afterwards was registered No. 1 in the Leicester Flock Book) writes: 'I have never crossed my flock from any other but by rams from the most noted Leicester breeders, and during the last forty years principally from the rams hired of, or descended from, the flocks of the following: White, Stubbins, Cresswell, Earnshaw, Farrow, Buckley, Robert and Joseph Burgess, Champion, Rose, Green, Smith, &c.'. This same old Yorkshireman issued a challenge for £1000 against any other parish in the kingdom in regard to the excellence of its flocks. All the farmers in the parish purchased their replenishing ewes from this pure-bred flock, and never thought of going farther afield for their sheep. The system of letting out rams for service continued a rule with the owner of this flock to within a few years of its final dispersal. The father of the present Sir Tatton Sykes of Sledmere was contemporary with the late Mr. Robinson of Carnaby, and the pair went into Leicestershire together to buy fresh blood. The then heir (he had not succeeded to the title of his uncle Sir Mark) awaited the arrival of his portion of the purchase at Hull, where he was engaged in a banking concern, and it is said he drove the sheep from thence to Pockthorpe Hall, near Driffield, which he then farmed. Sir Tatton may be credited with the introduction of Leicesters into that part of Yorkshire—the wold country,—and this type of sheep, with their pleasant-looking faces, have been 'at home' there ever since.

W. Youatt, in his valuable work on Sheep, has a good deal to say about Leicesters and their influence; and it seems almost impossible in discussing one breed to separate the other. Youatt wrote more than seventy years ago. He says 'there was a long and acrimonious contest between the Leicesters and the Lincolns for the point of supremacy. In one respect the Lincolns were decidedly inferior—they were fen sheep—they were made for and by the kind of pasture on which they were found; and when they were removed even to good keep, but in a different district, and of a different description, they rapidly deteriorated. The Leicesters would thrive wherever they found a sufficiently nutritious pasturage. The continuance, however, of the contest, and the doubt which even now exists in the minds of some with regard to the relative value of the respective breeds, show that the old Lincolnshire should not have been spoken of in so disparaging a way. Before they were allied to the Leicesters, and ill-formed and rough as they were, they had attained no small degree of excellence both in the carcass and the wool. At length a union was established between them. The Lincolnshire ewe was put to the Leicester ram, and the progeny certainly displayed, and to a very great and profitable extent, the excellencies of the male parent; the wether attained its maturity a full year sooner than it was accustomed to do, and with less comparative expense of food even in that time; and when the ewe was drafted, she too was sooner ready to be sent to the market, and weighed considerably more than she was wont to do, and was in higher repute and more readily sold.'

With the object of furthering the interests of breeders, a society, styled the Improved Leicester Sheep-breeders' Association, was established at Driffield, in the East Riding of Yorkshire, in 1893. The desirability of regulating the breed by a recognized standard had frequently suggested itself to those most interested. The scheme did not take root very rapidly; fortunately, however, the right men were found who were willing to co-operate in the movement, and Sir Charles Legard, Bart., of Ganton Hall, near Scarborough, became the first president, with Mr. J. J. Simpson, of Pilmoor House, Hunmanby, as vice-president; the presidential chair was filled in subsequent years by Mr. W. H. St. Quintin, of Scampston Hall; Mr. A. W. M. Bosville, of Thorpe Hall; and Lord Middleton, of Birdsall, whose tenure of office has extended over nine years. Mr. Joseph Crust, of Driffield, was the first secretary, and he worked hard to place the society upon a sound basis. In 1899 the society unfortunately lost the services of their secretary, after a long illness, and Mr. W. A. Brown, who had been associated with Mr. Crust in secretarial work, and in the preparation of the Flock Book ever since it was established, was unanimously elected to succeed him, and still holds that position. The society is much stronger now than at its inception, the membership having practically doubled within the past ten years. The word 'Improved' is no longer used as a prefix to the title of the society.

The following is the official description of the Leicester sheep, as approved by the Editing Committee of the association:—

'Lips and nostrils black, nose slightly narrow and Roman, the general form of the face wedge-shaped, and covered with short white hairs; forehead covered with wool; no vestige of horns; blue ears (sometimes white), thin, long, and mobile, a black speck on face and ears not uncommon; a good eye; neck short and level with back, thick, and tapering from skull to shoulders and bosom; breast deep, wide, and prominent; shoulders somewhat upright and wide over the tops; great thickness from blade to blade, or through the heart; well filled up behind the shoulders, giving a great girth; well-sprung ribs, wide loins, level hips, straight and long quarters; tail well set on, good legs of mutton, great depth of carcass, fine bone, a fine curly lustrous fleece (the sheep are well woolled all over) free from black hairs, with firm flesh, springy pelt, and pink skin. The general form of the carcass is square or rectangular; legs

well set on, straight hocks, good pasterns, and neat feet.'

Speaking on August 8, 1894, at a luncheon at Carnaby at the annual dispersal of rams (No. 1 Flock, before referred to), Mr. Crust said that 'but for the formation of a flock-book society there would soon have been no Leicesters—the breed would have been entirely lost'. He at the same time paid a well-deserved tribute to the breeders of rams, who at great expense, and with great anxiety, endeavoured to maintain the quality of their flocks. The aim of the breeder of any class of sheep is to produce an animal that is of general utility; its wool and its mutton should be equally important factors in the finished article. In animals domesticated for the use of man, the breeder steps in and replaces natural selection by artificial selection, his object being the gradual establishment of a type best suited, not for holding its own in the struggle for existence, but for furnishing the maximum amount of food and clothing for man, at the least expenditure of time and money. He has, of course, to work hand in hand with Nature and not against her, and consequently he has to adapt his processes to the laws which she has laid down. In so doing he is able to develop from diverse materials an animal which in essential qualities approximates to an ideal, but which at the same time retains many of the prominent features of the original. In reviewing the position of Leicesters in 1907, the secretary of the society stated: 'A particularly noticeable feature in connection with the breed was discernible at our leading agricultural shows this year—their increasing size and weight. When we recall the stamp of Leicester that was considered worthy of a first place eight or ten years ago, and compare it with the stamp and style of the sheep that are now exhibited, one cannot fail to see how great is the improvement. The Leicesters as exhibited to-day are a better type and much more useful sheep than the animals occupying leading positions a decade back. They have now more size and weight, both in respect of carcass and fleece, and at the same time the sheep retain all their old and well-known characteristics—the best of feeding properties, fine staple of wool, and early maturity. This improvement has been effected by the judicious mating of sires and dams, which in the hands of a skilful flockmaster has become a sort of fine art.'

The pure-bred Leicester of to-day is admirably adapted for use in our colonies. This statement has a solid basis, according to the leading experts. For the frozen-meat trade it has one great advantage over its compeers in the lustrous class and over the Down sheep, since the flesh of the pure-bred and crosses thaw out red after being frozen, as against the dark colour of all others. 'In New South Wales', says Mr. Prince, the secretary of the Sheep-breeders' Association in that colony, 'a big demand has set in for long-wools, for crossing and export sheep, and the Leicester is much in favour.' A New Zealand flockowner wrote in the Lyttelton Times: 'The reason for the demand for English Leicesters is that, crossed with the Merino, they give the ideal freezing sheep'. The manager of the New Zealand Government's experiment farm at Kiri Kiri-wa, Waikato, says: 'Of course one cannot speak too highly of the English Leicester in New Zealand, as it is *the* sheep of the South Island, Canterbury especially, and a part of the North Island, notwithstanding the slight difference of type, *i.e.* the blue versus the white face. Still, there can be no doubt they are rather inclined to switch back more to the English character, as evidenced by the many late importations, especially if the wool is heavy.

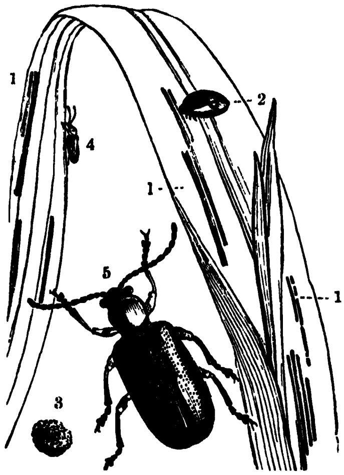
Shearling rams exported to New Zealand in recent years have been sold by auction at the following high prices: 120 gs., 112½ gs., 60 gs., 70 gs., 50 gs., 100 gs., 40 gs. Four ewes that were also sold at Christchurch realized 26 gs. apiece. With the object of encouraging the exportation of Leicester sheep, the society as well as individual members have presented cups for competition in the Argentine and in New Zealand.

A sale of male and female Leicesters was recently effected on behalf of a German farmer. This is believed to be the first exportation to that State; but the French have been customers for the last seventy years. The demand from across Channel arose through the increasing popularity of British wool in that country, a commission being sent over to England to examine our long-woolled sheep. The report was favourable. A flock of 110 ewes and a dozen rams were purchased in Leicestershire, and they were all disembarked at Havre without the loss of a single sheep. The sheep became habituated to the French shepherds and dogs, and retained their natural quiet habits, wandering far less over the pastures than the French Merino sheep; they were likewise less particular in their choice of food than either of the native or naturalized breeds, and fattened more quickly. They had been shorn in the preceding summer, and their fleeces had not suffered the slightest deterioration either in length, soundness, or lustre. Leicesters have also found their way into Spain and Denmark; a flock was established in Co. Longford (Ireland) in 1908, and Tasmanian farmers have purchased sheep of the highest merit in recent years for stud purposes. A consignment of twelve imported ewes with their imported lambs, and in lamb again to an imported ram, were sold in September, 1907 (as reported in the Melbourne Leader), on behalf of Mr. Geo. Simonds, of Stonor Estate, Tasmania, at prices ranging to 50 gs. per head. Mr. Oliver, another Tasmanian farmer, after visiting England and taking back with him a number of selected sheep from several flocks, wrote one of the vendors: 'Leicester sheep are selling better out here than they have done for years'.

The Leicester has come more into fashion of late years in England, and if a system of advertising its merits were adopted, its popularity would doubtless increase with rapidity. The breed achieved a notable success at the annual show of the Smithfield Club, held in the Agricultural Hall, London, in December, 1907, when

Mr. E. F. Jordan's pen of three wethers was awarded the champion plate for the best pen of long-woolled sheep in the show. They were also the reserve pen for the Prince of Wales's challenge cup for the best pen of sheep in the show. Apart from any other recommendation, these distinctions place the Leicester on a high pedestal in public favour. [W. A. B.]

Lema melanopa (the Oat Beetle) is the parent of a slug-like larva, which eats both surfaces of the oat leaves in long lines. The larva is pear-shaped, and ochreous or brown, with a



Lema melanopa (the Oat Beetle)

1, 1, 1, The injury to the leaf; 2, the larva; 3, the pupa; 4, the beetle, natural size; 5, the beetle, magnified.

little black head and six legs (fig. 2). It walks sideways as it proceeds down the leaf, nibbling between the striæ, causing spots and holes as the membrane dries and becomes brittle and discoloured. It spins a whitish cocoon upon or under the earth, to become a pupa in, and the beetle which emerges from it is shining deep-blue; the head and antennæ black; thorax red; legs ochreous; feet dusky; the wing cases are elliptical, and deeply punctured in lines, covering a pair of ample wings. [J. C.] [C. W.]

Lemon (*Citrus medica*, Linn., var. *Limonum*, nat. ord. Rutaceæ).—The reader will find in the art. CITRUS particulars as to the chief forms of that genus, such as the Orange, Lime, Citron, Lemon, and Pomelo; their botanical histories, and the more highly noted centres of their production. The present-day foreign trade in lemons and their products may be said to be concentrated in Sicily, just as that of the limes is in the West Indies. But lemons are largely cultivated throughout the Mediterranean coast and islands, as well as in the Canaries and the Azores. The name 'lemon' came to the English language from the Arabic *limun*, and through the Persian passed into the Hindi *limu* or *limbu* and *nimbu*. The lemon is often confused with the citron (*C. medica* proper), a variety that seems to have originated in Persia and in the East is now most frequently distinguished by its Persian name *turanj*. The lemon, on the other hand, seems to have been originally a native of Arabia. As cultivated in Sicily, two crops are obtained a year—a summer and an autumn or winter. The former is usually dealt with as fresh fruit, and the latter utilized in the more profitable local industry of production of oil of lemons, lemon juice, lemon peel, and citric acid. But in the manufacture of lemon juice the bergamot (from the south of Italy) and the lime (from the West Indies) may also be used. In the interest of the health of the plants it is regarded as unwise to allow two crops to mature on the same trees; hence the December is generally preferred, and the summer destroyed in flower bud. The trees begin to yield when about five years old; when twenty, they will give 1000 fruits; when in their prime, may afford from 3000 to 5000 a year. To prepare the oil or essence, and also the juice, the fruits are cut into convenient sizes, the pulp scraped out from these, and the peel soaked in water for an hour or two. The peel is then taken piece by piece in the hand and pressed while being held over a sponge. The oil is thus expressed and collected. If candied peel is to be prepared, only half the contained oil is removed; otherwise as much as can be obtained is taken from the rind, and the waste peel given to cattle. Similarly the pulp is compressed and the juice collected, while the refuse is used as cattle food. Citric acid may be manufactured from the juice of the lemon, lime, and bergamot. [G. W.]

Lentil (*Lens esculenta*, Moench; *Ervum Lens*, Linn.), an herb of the nat. ord. Leguminosæ. This much-valued pulse is generally accepted as indigenous to a wide area, such as western temperate Asia, Greece, Italy, and appears to have been carried into Egypt in very early prehistoric times. It is mentioned in the Bible, as, for example, in the story of the red pottage for which Esau sold to Jacob his birthright. It has been grown in India from fairly ancient times, though the uniformity of the name *masur* is suggestive of a common origin, and therefore of the plant having been introduced. It is in fact cultivated throughout the East and in many parts of Europe, Africa, and America. In India it is most abundantly produced in the Central Provinces, Madras, Bengal, and the United Provinces. It appears to prefer a clay loam or rich black soil to a light or sandy position, and follows rice (as a winter crop) rather than displaces wheat, though it is often produced as a mixed crop with barley. It is sown in October to December, and reaped from February to April. The yield seems to range from 500 to 700 lb., and with irrigation 800 to 1000 lb., to the acre, though as a mixed crop not more than 250 to 350 lb. may be obtained.

There are several very distinct kinds, the seeds varying in size, shape, and colour. The French lentil is of an ash-grey colour, of large size, and very flat form. The Egyptian and Indian kinds are much smaller, of a more rounded shape, and of an orange-red colour. The pulse is regarded in India as one of the most nutritious, second only to *mung*. A sort of soup made of the meal is one of the most

general forms of *dal*, eaten along with boiled rice and curry. The bitter substance may be removed by soaking in water to which a little carbonate of soda has been added. The split-pea is also parched, and in that form, as a food during a journey, is much appreciated. The young pod with its contained seed or seeds is often eaten as a vegetable, and the dried leaves and stalks are highly valued as a cattle fodder. There may be said to be two lentil meals in trade, one with and the other without the seedcoat. The latter

Lentil (*Ervum lens*)

is alone that which should be recommended. When mixed with a little barley flour and flavoured with salt, it is commonly sold in Europe under the names of Ervalenta or Revalenta, as a food for invalids. The powder made from the carefully decorticated pea is, in fact, held to be a useful domestic remedy for almost every form of indigestion and pains in the stomach, while being at the same time mildly aperient. [G. W.]

Leptus.—The classic designation of a mite commonly called the Harvest Bug. See art. TROMBIDIUM.

Lettuce, a hardy annual (*Lactuca sativa*) cultivated by the ancients as a salad plant, and of old introduction into this country. It is considered to be a cultivated form of *L. scariola*, which is a widely distributed weed. There are two distinct types—the Cabbage, which is chiefly grown for use in winter and spring, and the upright, or Cos, the leaves of which are more crisp and juicy. The Cos type derives its name from an island in the Greek Archipelago. Universally esteemed as the lettuce is in this country, it is grown to a much greater extent for winter use in France, while it is only in more southern countries that its health-giving and refreshing qualities can be appreciated to the full extent. Cultivated in every kitchen garden, the lettuce is grown on a vast scale for market. Large supplies are sent to this country from abroad during the winter months, but increasing attention is being devoted to their production by our market gardeners, lettuces forming, for example, a profitable winter crop in unheated greenhouses which in summer are filled with tomatoes, &c. The great point is to keep up a constant supply, by means of successional sowings, of a selection of varieties. Thus sowings should be made under glass from January till March, and afterwards in the open ground until September and October, when preparations are made for the autumn supply. In favoured localities the plants will stand through the winter outside without any protection, but the employment of frames is much to be preferred. Care must be taken not to promote a vigorous soft autumn growth, or a severe frost will kill the plants. The lettuce requires a rich, rather light soil, and the finest specimens are obtained by thinning the seedlings to, say, 1 ft. apart, without transplanting. The crop repays abundant waterings, and where these cannot be afforded and hot weather is anticipated it is wisest to grow the somewhat inferior red-leaved sorts, as adverse conditions cause the finer sorts to run up prematurely to seed. Frequent stirrings of the surface soil are beneficial, and a constant warfare by trapping, and by sprinklings of lime and soot, must be waged against slugs and snails. The better Cos varieties require tying to aid the production of crisp, white hearts. The following are among the best of the very large number of kinds: *Cabbage*—Early Paris Forcing, All the Year Round, Golden Queen, and Tom Thumb; *Cos*—Bath, Early Green, Paris White, Paris Green, and Superb White. [W. W.]

Lettuce.—Parasitic Fungi.—The commonest disease would probably be described by the grower as 'damping off'. Two species of fungi may produce this result. Lettuce Downy Mildew (*Peronospora*) is recognized by the formation on the leaf of yellow spots which bear patches of the white downy mildew on the lower surface. This disease resembles, therefore, the better-known potato mildew. The same fungus occurs also on artichoke, cineraria, and other species of Compositæ. Lettuce rot is recognized by the plants rotting off at the surface of the earth; the compact head also becomes rotten, and the leaves are covered with a greyish fungus (*Botrytis*) similar to that frequently seen on decaying flowers in greenhouses. See fig. in art. GRAPE VINE.

Treatment.—Downy mildew and rot are both favoured by overcrowding and a warm moist atmosphere, hence they are most destructive in

forcing-houses and frames. Overhead watering should be avoided if possible. Ventilation of covered structures during the day is essential, and the night temperature should not be allowed to exceed 50° F. Crowded beds of young plants will benefit considerably if transplanted to fresh soil, diseased plants being rejected and destroyed. Fresh clean soil may be needed in covered structures. [W. G. S.]

Leucin. See art. PROTEIN.

Leucojum (Snowflakes), bulbous European plants with white flowers, closely allied to the Snowdrops (*Galanthus*), their particular merit being that as they are larger and stronger growing they are more easily naturalized. The best species are: *L. æstivum*, summer-flowering, and *L. autumnale*, both requiring full sunlight; and *L. vernum*, spring-flowering, and best suited by a shady bank. Propagated by offsets, which should be removed as soon as possible after the foliage withers, and by seeds. [W. W.]

Levelling.—Levelling is the art of ascertaining and comparing the respective heights of fixed points on any piece of ground in their relationship to some assumed horizontal line, or 'datum' as it is technically termed. The standard datum line in Britain is the assumed mean level of the sea at Liverpool, which is ·650 of a foot below the mean level of the sea in general. On the two series of our Ordnance Survey Maps—the 25·344 inches to the

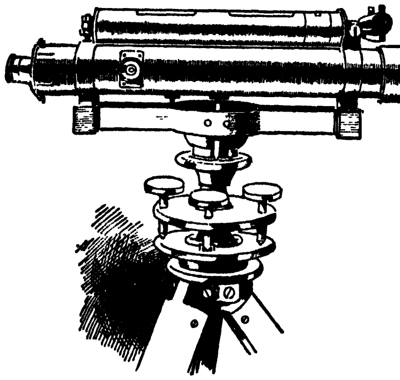


Fig. 1.- Dumpy Level

mile scale and the 6 inches to the mile scale—there are every here and there 'bench marks', which indicate the height above sea level of the points referred to. For instance, we see B.M. at a certain point and near to it the sign  (the Government broad arrow with a short line across its apex), and, say, 25·36 accompanying the letters. This is to the effect that the cross of the bench mark, wherever the latter happens to be carved out in stone, whether of building, wall, gate pillar, or milestone, is that height above sea level or the standard datum line of the country. In order to ascertain the figures pertaining to any bench mark we come across either in town or country, we have of course to turn to the sheet of either of the two series of maps referred to and corresponding to the locality of the bench mark in question. In addition to these bench marks there are on both sets of maps figures, at more or less regular distances apart, on the principal roadways, indicative of the altitudes or heights above datum of these respective points, put in this way, + 45·29. On the 6-in. maps there are contour lines as well, that is to say lines representing equal heights above datum wherever they pass through. (See CONTOURS.) Contour lines are given on the inch-to-the-mile series of maps too, but neither bench marks nor ordinary altitudes. No one can estimate the cost of a proposed roadway, embankment, or excavation unless he has before him sections of the surface of the ground that is to be involved in the operation. But with this available he can calculate with accuracy the quantities of stuff that have to be excavated here, banked up there, or be shifted from the place altogether and tipped out of the way elsewhere, be brought from some other site to make up deficiency on the spot, and so on. It is for work of this sort, and for deciding on doubtful gradients in the matter of field draining, and making sure of sufficient 'head' when dealing with water supplies, that levelling comes into exercise on estate and farm. For this purpose the ordinary 'dumpy' level is made use of. Fig. 1 is a representation of the same, showing, however, only a portion of the tripod or three-legged stand on which it is fixed. Together with this goes the staff or figured rod for setting up at the points the relative heights of which we wish to ascertain. The staff in common use (fig. 2) is graduated to hundredths of a foot. The feet are in red figures, the odd numbers of the tenths in black figures, while the hundredths or subdivisions of the tenths are indicated by the alternate bars in black and white. It draws out and in telescope-wise in three sections. As an example of actual proceedings on the ground, suppose we wish to know the difference in level between A and C, fig. 3. It might be practicable to do this at one setting up of the instrument. We are assuming, however, that two readings are required—one between A and B, another between B and C. The level is set in position, therefore, between A and B; not necessarily in a direct line or exactly halfway between, but at the most convenient or suitable place for the purpose. When the instrument has been adjusted the staff is set up at A, and the reading thereon that coincides with the centre of vision through the telescope noted—5·23 let it be. Next the telescope is brought to bear on the staff now removed to B, when the reading is 4·16, which shows that B is 1·07 above A. The reading at A is, we may say, a back-sight, while that at B is a fore-sight. The level is then removed to a suitable position between B and C and readings taken as before. This time the staff, which still remains at B, but is now turned to allow the figures to be read from the other side, is a back-sight, reading let us say 6·22. When this has been noted the staff is removed

Fig. 2

to c and the reading of that fore-sight marked down. Assuming it to be 8·24, there is thus a difference of 2·02 between B and C, the latter point being that much lower than B. But B is 1·07 above A, therefore C is ·95 or barely a foot lower than A. It often happens that one can take a considerable number of readings without shifting the instrument. This depends, of course, on the power of the telescope on the one hand, and on the other on the configuration of the ground. The steeper the ground the closer together back-sight and fore-sight require to be

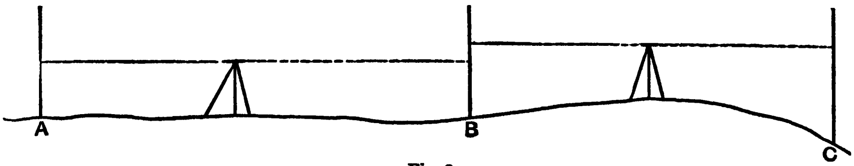


Fig. 3

placed when readings are being taken; conversely, the flatter it is the farther apart they may be kept consistently with the power of the telescope. The following is the usual form in which the level book is kept. In the second column there is included a series of subsidiary readings termed intermediate sights, *i.e.* sights taken between a back-sight and a fore-sight:—

Back-sight.	Intermediate.	Fore sight.	Rise.	Fall.	Height above Base.	Distance (feet).	Total Distance (feet)	Remarks.
7·52	—	—	—	-	10·	—	—	
—	6·62	—	·90	--	10·90	50	—	
—	7 01	—	—	·39	10·51	35		
—	4·95	—	2·06	—	12·57	115	—	
	2·30		2·65	—	15·22	50	—	
—	1·44	—	·86	—	16 08	50	—	
--	2·60	—	—	1 16	14·92	70		
—	—	2·40	·20		15·12	15	385	

Fig. 4 gives the completed section (small and unimportant of its kind, of course) plotted from the above level book, showing true to scale the configuration of the ground along the straight

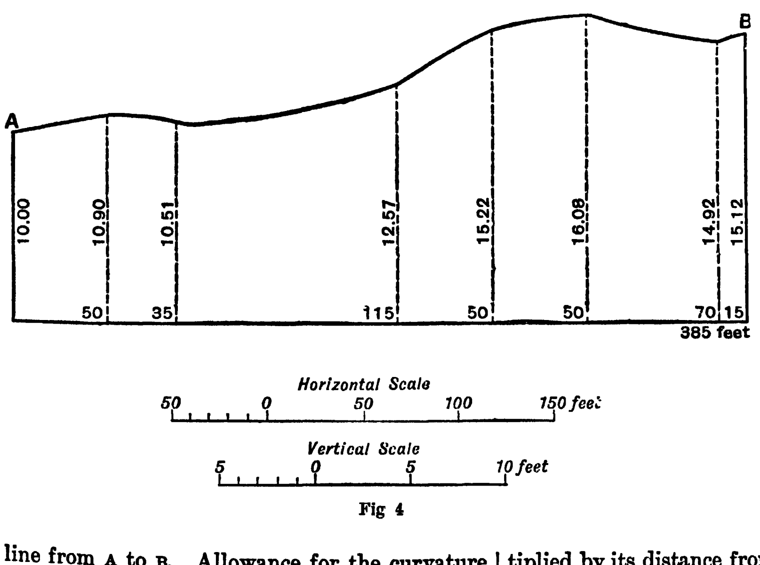


Fig 4

line from A to B. Allowance for the curvature of the earth and for the refraction of light as well is given heed to in levelling operations on a large scale, but in neither case need it be taken into account in work such as we are supposing. [R. H.]

Leveret, the young of the hare.

Levers.—Levers are primarily mechanical devices to perform work more easily than can be done by direct lift. It has been customary to divide the simple levers into three orders, first, second, and third, according to the relative positions of the power, weight, and fulcrum. Three forces are recognized — the power, weight, and reaction of the fulcrum. The point of application is called the fulcrum; the point where the load is brought to bear, the weight; and the point where force is applied, the power. The arms of the lever are those portions lying between the fulcrum and the power, and between the fulcrum and the weight. The accepted principle of the lever is that the power multiplied by its distance from the fulcrum is equal to the weight multiplied by its distance from the fulcrum, whatever the relative positions of the power, weight, and fulcrum. Moreover the principle is true whether the lever is straight or not, or whether the forces are at right angles to the lever or inclined; but it must be under-

stood that the distance of the power and weight from the fulcrum is the perpendicular distance of the lines of action of these forces. In respect to the orders of levers as represented on the farm, the cart jack, steelyard, a set of whippletrees, are examples of the first; the hop dog, and the knife blade in an old-type chaff cutter, of the second; the safety valve of a steam engine, and a man raising a ladder, of the third. In their application to machinery such as mowers, reapers, cultivators, drill coulters, they are frequently used in conjunction with notched quadrants and spring bolts to alter the relative position of one part of a machine to another, as a means of regulating the working. The bell-crank lever is used on steam engines to regulate the supply of steam from the boiler to the steam chest through the throttle, by means of a link action between the governors and the throttle valve. The bell crank was the first form of lever applied (by Finlayson) to lift cultivators out of work; but modern cultivators are generally designed to admit the relative position of the frame to the main axle to be altered by quadrant levers. [W. J. M.]

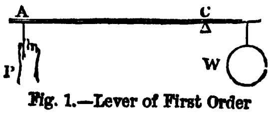


Fig. 1.—Lever of First Order

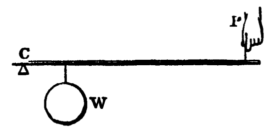


Fig. 2.—Lever of Second Order

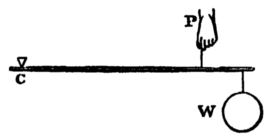


Fig. 3.—Lever of Third Order

P, Power; W, weight; C, fulcrum.

Levulose. See art. SUGARS.

Licences.—A considerable portion of the revenue of the country is derived from the Excise duties, of which the most important are those imposed on the sale of wines, beers, and spirits. The consideration of the spirits, &c., duties would not be relevant to the present work, but there are a number of licences which require to be taken out annually which are more likely to be of interest. They are as follows:—

ARMORIAL BEARINGS.—If such armorial bearings shall be painted, marked, or affixed on or to any carriage, £2, 2*s*.

If such armorial bearings shall not be so painted, marked, or affixed, but shall be otherwise worn or used, £1, 1*s*.

'Armorial bearings' includes any armorial bearing, crest, or ensign; and any person who shall keep a carriage, whether owned or hired by him, shall be deemed to use any armorial bearings affixed thereto. It is not necessary for a licence to be taken out by any person duly licensed to keep or use a public stage or hackney coach, in respect of armorial bearings thereon, or on the harness used therewith. A licence does not require to be taken out by any officer or member of a club or society, being at the club, or on the business of the society, any armorial bearings for the use of which the club or society have taken out a licence.

AUCTIONEERS.—Every person who carries on the trade of an auctioneer or who acts in such a capacity at a sale or roup, £10.

CARRIAGES.—If such carriage shall have four or more wheels and shall be drawn or adapted to be drawn by two or more horses or mules, or shall be drawn or propelled by mechanical power, £2, 2*s*.

If such carriage shall have four or more wheels, and drawn or adapted to be drawn by one horse or mule only, £1, 1*s*.

If such carriage shall have less than four wheels, 15*s*.

Every hackney carriage, *i.e.* a carriage standing or plying for hire, 15*s*.

A carriage or hackney carriage which anyone commences to use on or after 1st October in any year is liable in one-half the duty which would otherwise be payable in respect thereof.

The term 'carriage' includes any carriage (except a hackney carriage) drawn by horses or mules, or drawn upon a road or tramway; but does not include a wagon, cart, or other such vehicle used solely for the conveyance of goods or burden in the course of trade or husbandry, whereon the Christian name and surname, and place of abode or place of business of the person keeping the same shall be visibly painted in letters not less than 1 in. in length. A licence does not need to be taken out by a farmer for any wagon or cart used for conveying the owner or his family to or from any place of divine worship on Sunday, or on Christmas Day, or on Good Friday, or on any day appointed for a public fast or thanksgiving, provided such wagon or cart is otherwise used solely for the conveyance of burden in the course of husbandry, and is duly marked as above noted. Nor is a licence required for farm or trade carts lent to carry passengers other than the owner or his family gratuitously on special occasions or holidays.

DOGS.—The licence expires on 31st December in each year, 7*s*. 6*d*.

Exemptions.—1. Blind persons do not require a licence for a dog kept and used solely by them for their guidance.

2. Farmers and shepherds keeping sheep dogs are entitled to exemption for dogs used solely for tending sheep or cattle, or in the exercise of the calling of a shepherd. Two or more dogs, but not exceeding in all eight, may be kept, in proportion to the number of sheep on common or unenclosed land. Thus the owner of more than 400 sheep may get exemption for a third dog, the owner of 1000 sheep for a fourth dog, and thereafter for one additional dog for every 500 sheep beyond 1000 up to the limit of eight dogs. In order to obtain this exemption a declaration has to be filled up, and in return a certificate of exemption received from the Commissioners of the Inland Revenue. The certificate requires the previous consent in England of a petty Sessional Court, and in Scotland of the sheriff or sheriff-substitute having jurisdiction in the place where the dog is kept. The consent shall not be withheld if the Court

is of opinion that the conditions for exemptions apply. (See under Dog.) The use of a dog by a farmer or shepherd in taking rabbits or game will disentitle him to exemption. Butchers and drovers who occupy land for their trade are not entitled to exemption.

3. No licence is required for any dog under the age of six months.

4. Where the owner or master of a pack of hounds has taken out proper licences for all the hounds entered in any pack kept by him, it is not necessary for him to take out a licence in respect of any hound under the age of twelve months which has never been entered or used with the pack.

Game.—Every person who shall use any dog, gun, net, or other engine for the purpose of taking or killing any game whatever, or any woodcock, snipe, quail or landrail, or any conies, or any deer, or shall take or kill by any means whatever, or shall assist in any manner in the taking or killing by any means whatever, of any game, or any woodcock, snipe, quail or landrail, or any coney, or any deer, must have a licence.

If taken out after the 31st day of July and before 1st November—

To expire on the 31st day of July in the following year, £3.

To expire on the 31st day of October in the same year as the licence shall be taken out, £2.

If such licence shall be taken out on or after the 1st day of November—

To expire on the 31st day of July following, £2.

For a continuous period of fourteen days, to be specified in the licence, £1.

Exceptions.—1. The taking of woodcocks and snipe with nets or springes in Great Britain.

2. The taking or destroying of conies in Great Britain by the proprietor of any warren or of any enclosed ground whatever, or by the tenant of lands, either by himself or by his direction or permission.

3. The pursuing and killing of hares respectively by coursing with greyhounds, or by hunting with beagles or other hounds.

4. The pursuing and killing of deer by hunting with hounds.

5. The taking and killing of deer in any enclosed lands by the owner or occupier of such lands, or by his direction or permission.

Exemptions.—1. Any of the Royal Family.

2. Any person appointed a gamekeeper on behalf of His Majesty by the Commissioners of Woods, under the authority of any Act of Parliament relating to the land revenues of the Crown.

3. Any person aiding or assisting in the taking or killing of any game, or any woodcock, snipe, quail, landrail, or coney, or any deer, in the company or presence and for the use of another person who shall have duly obtained, in his own right, a licence to kill game, and who shall by virtue of such licence then and there use his own dog, gun, net, or other engine for the taking or killing of such game, &c., and who shall not act therein by virtue of any deputation or appointment.

4. And, as regards the killing of hares only, in England any owner or actual occupier of enclosed land who has the right of killing game thereon, and in Scotland any person who has the right to kill hares, or anyone authorized in writing by such persons, may do so without a game licence.

5. Occupier of land and persons duly authorized by him, in terms of the Ground Game Act, 1880, do not require a game licence for the purpose of killing ground game on land in the occupation of such occupiers. Occupier may sell game so killed as if he had a licence to kill game. See Game Laws.

Gamekeepers.—Any person having the right to kill game on any lands in England or Scotland shall be entitled to take out a licence to authorize any servant, for whom he shall be chargeable to the duty on male servants as a gamekeeper, to kill game upon the same lands, upon payment of the duty of £2. The licence shall exempt the servant therein named during his continuance in the same capacity and service, and on his quitting such service shall also exempt any servant who shall succeed him in the same service and capacity, within the year for which the licence is granted. The licence is not available for acts done on lands whereon the master has not a right to kill game. The employer must in addition pay the duty for a male servant (see below). Gamekeepers in Ireland are chargeable at the rates specified above under heading *Game.*

Gamedealers.—Every person licensed to deal in game by the justices of the peace shall pay annually £2.

A licence is required for dealing in game imported from abroad.

Gun.—Every person who shall use or carry a gun in the United Kingdom shall pay for the year ending 31st July, 10*s*.

Exceptions.—A licence does not require to be taken out by the following persons, viz.:—

1. By any person in the naval, military, or volunteer service of His Majesty, or in the constabulary or other police force, using or carrying any gun in the performance of his duty, or when engaged in target practice.

2. By any person having in force a licence or certificate to kill game.

3. By any person carrying a gun belonging to a person having in force a game or gun licence, and by order and for the use only of such licensed person, if the person carrying the gun shall, upon the request of any officer of inland revenue or constabulary, or any constable, owner, or occupier of the land on which such gun shall be used or carried, give his true name and address, and also the true name and address of his employer.

4. By the occupier of any lands using or carrying a gun for the purpose only of scaring birds or of killing vermin on such lands, or by any person using or carrying a gun for the purpose only of scaring birds or of killing vermin on any lands by order of the occupier

thereof, who shall have in force a game or gun licence. In order to shoot birds of any kind—other than game—it is necessary to have a gun licence, though for the purpose of merely scaring them it is not necessary to have a licence.

Rabbits are not included under the term 'vermin'. See under GAME LAWS—'Ground Game Act'.

5. By any gunsmith or his servant carrying a gun in the ordinary course of the trade of a gunsmith, or using a gun by way of testing or regulating its strength or quality in a place specially set apart for the purpose.

6. By any person carrying a gun in the ordinary course of his trade or business as a common carrier.

MALE SERVANT (15*s.*).—The term 'male servant' includes any male servant employed either wholly or partially in any of the following capacities; that is to say, *maître d'hôtel*, house steward, master of the horse, groom of the chambers, valet de chambre, butler, under butler, clerk of the kitchen, confectioner, cook, house porter, footman, page, waiter, coachman, groom, postilion, stable boy or helper in the stables, gardener, under gardener, park keeper, gamekeeper, under gamekeeper, huntsman, and whipper-in, or in any capacity involving the duties of any of the above descriptions of servants, by whatever style the person acting in such capacity may be called; but shall not include a servant who, being *bona-fide* employed in any capacity other than the capacities above referred to, is occasionally or partially employed in any of the said capacities, and shall not include a person who has been *bona fide* engaged to serve his employer for a portion only of each day and does not reside in his employer's house.

Exemptions.—1. An officer in His Majesty's army or navy for any servant being a soldier, or on the books of a ship, and employed by such officer in accordance with the regulations of the service.

2. Any licensed retailer of exciseable liquors or licensed keeper of refreshment house, or temperance, hydropathic, or other hotel keeper, for any servant employed solely for the purposes of his business.

3. Any horse dealer or livery stable keeper, or person who lets horses for hire or keeps a horse for drawing a public stage or hackney carriage, for any servant employed in the business at the trade premises, provided entry of his premises had been made in terms of law. But if a horse and carriage be let on hire for a period exceeding twenty-eight days the duty must be paid.

4. Any person licensed to keep a stage or hackney carriage for any servant employed to drive such, or to take charge of such or of the horses required therefor.

Agricultural or trade servants who attend merely to horses used for drawing carts, wagons, &c., which do not attract carriage duty do not require licences. Nor does a mere game watcher who does not perform any of the duties appertaining to a gamekeeper. [D. B.]

Lichens.—Wherever man has found rocks, stones, or trees, from the farthest Arctic lands southwards to the Antarctic, there Lichens occur from sea level to the highest rocky summits. Lichens, with some of the lower forms of Algæ and Bacteria, are the first living organisms to become established on recently exposed rock and soil, and in this way they prepare soils suited to higher plants. In Britain Lichens may be found almost everywhere, but it has been observed that they are absent where smoke or town fogs pollute the atmosphere.

The position of Lichens in the vegetable kingdom is amongst the Thallophytes intermediate

Fig. 1.—*Parmelia tiliacea*, a Foliaceous Lichen bearing Ascus-cups (*ap*)

between Algæ and Fungi. Their external form varies considerably: the *crustaceous lichens* form crusts and adhere so firmly to their substratum that they cannot be detached without injury; *foliaceous lichens* have a flattened leaf-like thallus which adheres rather loosely; *fruticose lichens* are like tiny shrubs attached by a small stem bearing branches. The texture of Lichens during a wet season varies from the consistency of a soft jelly to that of tough leather, the colour ranging from grey to yellow or brown; during a dry time they shrink and appear as lifeless dirty-brown masses, as brittle crusts, or as grey stringy tufts.

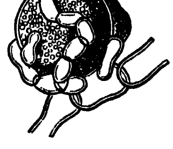


Fig. 2. — Fungus Filaments of a Lichen (*Cladonia*), enclosing an Alga (*Protococcus*)

Lichenology is an old study, but not till forty years ago was it known that a lichen plant was really a composite organism made up of a fungus and an alga living in mutual partnership or symbiosis (see art. SYMBIOSIS). The fungus-filaments enclose the algal cells, and the two organisms together compose the lichen-thallus (fig. 1). The algal cells possessing chlorophyll are able to construct organic carbon-compounds, and these are shared by the fungus. Neither organism is exhausted, and the lichen as a whole is better able than either of its separate constituents to secure food, to resist drought and heat or cold, and to live where there is little competition from other plants. The Algæ which enter into this symbiosis are either Blue-green Algæ (*e.g. Nostoc*), or simple forms of Green Algæ (*e.g. Protococcus*) (see art. ALGÆ). The Fungi concerned are generally Ascomycetes (see art. FUNGI). The reproduction of Lichens is effected chiefly by brood-buds (*soredia*); these appear on the Lichen as greyish dust, each

particle consisting of a few fungus-filaments wrapped round a few algal cells. These brood-buds are carried off as dust, and settling down give rise to new plants. The fungal part frequently produces its own ascus-fruits or other reproductive bodies (fig. 2).

Lichens have some economic uses. Iceland Moss (*Cetraria islandica*), a shrubby northern lichen, contains a large amount of a carbohydrate, Lichenin or Lichen starch, and the nutritive properties of this, combined with the soothing effect of the boiled thallus in throat troubles, has given this lichen a certain medicinal reputation; it is eaten by grazing animals, and in famine seasons by man in Iceland and Arctic regions. Reindeer Moss (*Cladonia rangiferina*), the principal winter grazing for reindeer in Arctic Europe, is also abundant on our own moorlands, and in Norway is sometimes collected as winter fodder for cattle. Lichens also furnish 'cudbear' and other dyes formerly used in Scotland for dyeing homespun cloth. Litmus, the well-known test for acids and alkalis, is obtained from *Roccella*, a seaside lichen; under the name Orchil, or Orchella-weed, this and other lichens were formerly much used as a purple dye. Some species of *Lecanora*, a common crustaceous lichen in Britain, appear as deposits of 'manna' on the ground in Central Asia, and serve as food for man and beast. In the orchard and tree nursery, lichens and mosses may coat the trees and act as shelter for insect pests to such an extent that they have to be removed by washes of caustic soda or other alkalis (see next art., also FUNGICIDES). [W. G. S.]

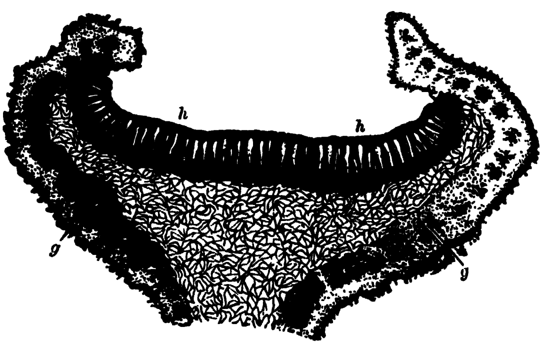


Fig 3.—Section through Ascus-cup of a Lichen

h, Layer of asci and sterile hairs; *g*, Algal cells forming a definite subcortical layer.

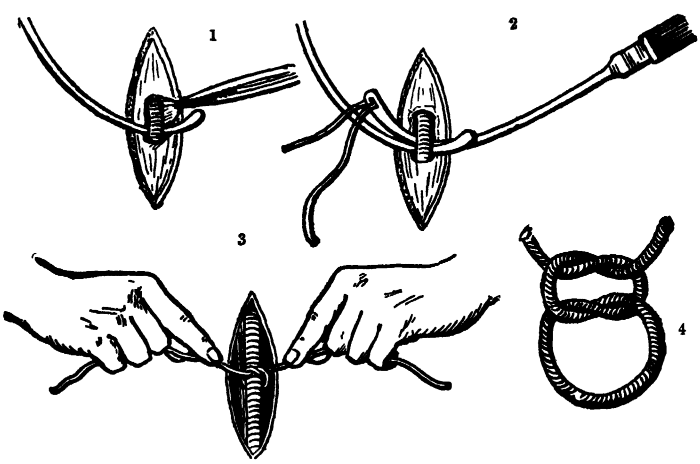
Lichens—Damage to Trees.—Lichens on the bark of trees are not necessarily an unhealthy sign in damp localities, although any tendency to become much overgrown certainly indicates a more or less impaired vitality resulting from want of free circulation of air about the stems, because it results in the lenticels of the bark being interfered with and becoming clogged. When the growth of the tree in girth is very slow in damp localities, the bark is shed so gradually that the lichens are easily able to grow on it, and then they mechanically close the lenticels or air-holes through which the tree transpires and absorbs oxygen, so that in course of time the health of the tree becomes affected and branches die off inside the crown. And in damp sheltered places, where the lichens soon increase in large numbers, many trees may be killed by them, and the unhealthy condition may spread. Ornamental trees may be washed and brushed, or scraped and pruned to free them from lichens; but the prevalence of lichens in woodlands shows that the situation is not well suited for the kind of tree that has become lichen-covered. A good wash for lichens is 1 lb. sulphate of iron to 1 gal. of water; or a stronger wash, which must be used with care, is 1 lb. caustic soda and 1 lb. pearl ashes, each dissolved in 5 gal. of water, then mixed, and ¾ lb. of soft soap added. [J. N.]

Liebig, Justus, Baron von, an illustrious chemist, who devoted much of his great learning and indefatigable industry to the chemistry of agriculture. He was born at Darmstadt in 1803, and after his school-days and a brief sojourn with an apothecary, he studied at the University of Bonn, at Erlangen, and at Paris. At Erlangen he received the degree of Doctor of Medicine. At the early age of twenty-one, Liebig read a paper on certain organic compounds before the Institute of France, and in the same year of his life he became extraordinary professor of chemistry at the University of Giessen. Two years later he was appointed ordinary professor in that university. A laboratory which he established for teaching practical chemistry soon attracted students from many countries, including some British students who afterwards became noted, among whom were Lyon Playfair, J. H. Gilbert, Johnston, Augustus Voelcker, and Gregory. Before he began to devote special attention to the chemistry of agriculture, Liebig wrote and lectured on other branches of chemistry, which are beyond the scope of this notice. His first work on agriculture was Chemistry in its Application to Agriculture and Physiology, which was translated by Dr. Lyon (afterwards Lord) Playfair, and introduced by the translator in 1840 to the British Association for the Advancement of Science, to which body it was dedicated. This era-marking book excited great attention, and led to a great deal of controversy. Although there was much in it which has not stood the test of time, it gave a more comprehensive description of the nutrition of plants than any work previously issued. The chief subject of controversy then and afterwards in relation to Liebig's writings on agriculture was his 'mineral theory', which exalted inorganic over organic manures, and specially over their most important element, nitrogen. In this he was opposed by most other chemists, including Lawes and Gilbert in England and Boussingault in France. In 1855 Professor Gregory, of Edinburgh, translated and published Liebig's Principles of Agricultural Chemistry, with Special Reference to the late Researches made in England, referring to the experiments of Lawes and Gilbert at Rothamsted and the deductions derived there-

from by their conductors. There is no doubt that the noted German chemist conferred a great service upon agriculture by his demonstration of the importance of mineral manures, though he erred in correspondingly underrating the importance of applications of nitrogen to crops by farmers, on the ground that this element was to a great extent supplied naturally and constantly. Although he may have modified his views in a later period of his life, as long after their first promulgation as 1863, when his Natural Laws of Husbandry, edited by Dr. John Blyth, of Queen's College, Cork, was published, he alluded to an experiment indicating that a field, after a four-course of crops, had received more nitrogen in rain than had been removed by the crops as justifying the assertion 'that a farmer need trouble himself as little about a compensating supply of nitrogen as of carbon'. In this argument the great loss of nitrogen in water draining off the surface or through the soil is ignored. There was, however, much more insistence upon the necessity of supplying such nutritive substances as phosphoric acid and potash, which of themselves are only slightly movable, and are not naturally restored, rather than those which possess the power of circulation, and, in part at least, come back to a field spontaneously every year. Other important works by Liebig are Animal Chemistry, Researches in the Chemistry of Food, Familiar Letters on Chemistry, and The Motions of the Juices in the Animal Body. In 1852 Liebig became professor of chemistry in the University of Munich and director of the Chemical Laboratory, and in 1860 President of the Academy of Science. He died at Munich in 1873. Among the numerous honours which the great chemist received was the title of hereditary Baron, conferred upon him by the Grand Duke of Hesse, in 1845. Before this he had been elected a Fellow of the English Royal Society, and at one time or another he became a Fellow of learned societies in most of the countries of Europe.

[W. E. B.]

Ligatures. — Ligatures are employed in many departments of veterinary surgery, and a knowledge of their use has ofttimes saved the life of a valuable animal when serious hæmorrhage has resulted from accidental wounds (see BLEEDING). They are composed of many different materials, the primary principles being suitability to the particular purpose, as, for instance, in the case of pressure being desired upon a limb to prevent hæmorrhage, and requiring stout cord, or a handkerchief with a stick passed under it, to act as a tourniquet; and the finest of thread or silk to tie an artery or ligature a wart on the eyelid. Every grade of thickness and strength may be desired for one purpose or another in connection with animals. The materials chosen, where indeed choice and not urgent necessity rules, should be strong and inelastic, or they will break or slack out and fail of their purpose. Among those generally in use may be named silk, thread, horse hair, twine, string of various thickness, tarred cord, and rope varying from the thin end of a plough line to that of a wagon rope. Besides the conservative ligatures above indicated, there are destructive ties intended to cut off circulation, as when tumours are ligatured, or the testicles or other organs or parts of which it is intended to deprive



Ligatures for Arresting Bleeding

1, Probe lifting an artery while the forceps holds back its sheath. 2. Needle inserted and threaded. 3, Tying a ligature. 4, Correct knot for a ligature

the animal. The methods of tying are set out and further illustrated in connection with the subject of WOUNDS. [H. L.]

Light-demanding Trees are those which do not thrive unless their crown of foliage is freely exposed to the sunlight and the air. Trees vary greatly as regards both the amount of light they require in order to enable them to carry on their physiological functions properly, and also their capacity for accommodating themselves to unfavourable conditions as to sunlight. All our woodland trees grow most luxuriantly when fully exposed to sunlight and air, although Beech and Silver Fir seedlings require a light shade for the first two or three years. But as soon as they have passed through the thicket stage of growth, both these and other kinds of trees exhibit well-defined special requirements as to light and individual growing-space; and if their natural requirements in this respect be not provided for (*e.g.* as by thinning), then young trees gradually sicken and die. Spruces, Silver and Douglas Firs, Giant Arborvitæ, Beech and Hornbeam can stand most shade from the side or from

above, and therefore form the thickest woods, and are called 'shade-enduring'. Less shade is endured by Weymouth Pine, Alder, Maple, Sycamore, Lime, and Horse-chestnut; but all our other forest trees are more or less distinctly 'light-demanding', such as Oak, Ash, Elm, Sweet Chestnut, Scots, Austrian, and Corsican Pine, Willows and Poplars, Robinia, Mountain Ash, Larch and Birch, these last two being the most light-demanding of all. The poorer the soil, and the drier it is, the more marked is the demand for light exhibited by any tree. In the coppices and underwoods Hazel, Ash, Sweet Chestnut, Maple, Sycamore, Lime, Mountain Ash, Holly, and shrubs like Dogwood, &c., endure a considerable amount of shade. In any kind of tree the capacity for enduring shade on any given soil or situation is shown by the length of time overshadowed twigs remain alive, and by the thickness of the foliage (and by its persistence in evergreens). But nothing is known as to the absolute quantity of light needed for the assimilative process by any tree. [J. N.]

Lighting of Farm Buildings.—In the following remarks it is proposed to deal mainly with the artificial lighting of the steading. The methods of securing the efficient entrance of daylight into those buildings designed for the accommodation of live stock are fully discussed in the arts. BUILDINGS, FARM; BYRES; and STABLE; and only a short recapitulation is given here.

The byre is generally lighted by means of roof-lights, and a minimum of 3 sq. ft. of glass should be allotted to each cow. The light should be so directed that it falls on the food troughs, as it is here that dirt and disease germs are most liable to collect. In most modern byres the roof-light runs the entire length of the byre; but in double-rowed byres, where the milking passage runs up the centre of the building, the light enters from windows in the walls. The stable is generally illuminated by wall windows, which in warm weather also assist in ventilation. In the absence of a hayloft above the stable, supplementary lighting may be obtained from the roof. The barn and granary are often the worst lighted parts of the farm steading, lighting usually being obtained from the doors, small skylights, or even from slits in the walls. In the reconstruction of existing buildings, or in the erection of a new steading, adequate provision ought to be made for the efficient lighting of these parts by suitable windows or roof-lights. It is scarcely possible to have our buildings overlighted. Darkness obscures dirt and fosters disease; the best and cheapest germicide is sunlight.

Artificial lighting should only be necessary at night or during the dark days of winter. By far the commonest illuminants in use are petroleum and paraffin oils, and lighting by means of petrol gas, acetylene, or electricity is the exception rather than the rule. In using these oils, care ought to be taken in selecting a suitable lamp. Many of those in common use emit a feeble light, are continually smoking, and have an offensive smell. A lamp suitable for the byre and stable is described in the art. LAMPS. Though the initial outlay for lamps and accessories is small, yet taking into account the occasional breakages of globes and the price of oil, the running cost of this illuminant is probably more expensive than either petrol or oil gas.

Except where the farm is in close proximity to the town, coal gas is never used for lighting the steading. Of late years, however, petrol gas or air gas and oil gas have attracted the notice of landowners and estate agents owing to their superior illuminating power, to the cheapness of installation of the plant, and to the low running cost. Petrol gas as made by the Safety Light process is a weak mixture of petrol vapour and a large proportion of air, and is obtained by dropping a measured quantity of petrol by automatic means into a carburettor, where it is entirely evaporated by suction. The best results are obtained when the excess of air is so large that the mixture is non-explosive. The power necessary for working the plant is obtained from a water supply or from the falling of a weight. In the former case a small water motor is used to drive an air pump, which delivers a measured volume of air at each stroke. Connected with the pump and working simultaneously with it is the petrol regulator, which delivers a definite quantity of petrol to the carburettor at each stroke of the pump. The air is first drawn through the purifier, where all moisture is removed; it is then passed through the carburettor, where it meets the petrol vapour and is converted into gas, and from thence it is delivered to the gasholder, attached to the top of which is a lever controlling the water supply. When the gasholder is full the water supply is cut off until some of the gas has been used, when the water-control valve is again turned on and more gas made. The working of the plant is very simple. The only attention required is the replenishing of the petrol tank when necessary; all the other operations are entirely automatic. The cost of installing forty lights by this method is slightly over £50. The cost of petrol to produce 1000 cu. ft. of gas is about 1*s.* 8*d.* It is claimed that the quality of the light is far superior to coal gas, and is clearer than acetylene or electricity. Petrol gas is also made by the Mitchelite system by a similar principle, but here the gasholder is done away with, the gas being delivered direct from the mixing chamber or carburettor. The cost of plant supplying fifty lights by the Mitchelite process runs about £40, and 1 gal. of petrol will produce 1000 cu. ft. of gas.

Acetylene is also employed in many country residences as an illuminant, but it is not an economical method of lighting. For details of manufacture and cost of installation, see the art. ACETYLENE.

The cost of installing plant for producing electricity is at present too high to warrant its general adoption on the farm. A complete plant, including oil engine, dynamo, wires, lamps, &c., for producing twenty lights would probably cost from £200 to £250. But where the motive power is supplied by a water turbine, or even

by a windmill, the capital expenditure would be much less. Still, the running cost is three or four times greater than in the case of petrol gas. [R. H. L.]

Lightning, Damage done by.—Lightning is at times destructive to the live and dead stock on a farm, and occasionally ripening crops have been destroyed by fire originating from a flash of lightning which has set on fire stacks in the proximity, though we are unaware of an instance of a growing crop being directly fired by lightning. The most frequent form of damage is that where animals sheltering under trees are struck by flashes attracted by the trees. How far the presence of animals at the base of a tree increases the liability of the tree to be struck is a moot point, but it is certain that personal observation goes to show that frequently the tree which is sheltering animals is the only one struck out of a large number near by; on the other hand, we know of cases where animals have been sheltering under a tree at the time it was struck which have not suffered. The effect of actual contact is very marked. In a flock of several hundred sheep we observed that twenty-four sheep which were in actual contact with the hurdles were killed, while all others were uninjured, though many were less than a foot from the hurdles. The dead sheep were in a space of fully a hundred yards, showing that the lightning had run the whole length. As is usual, there were very slight traces of injury immediately after death. In another instance, a ewe in a flock in the middle of a field was struck in the forehead, and a circular hole nearly 2 in. across had been made; her two lambs touching her were killed; the current split into three. No other sheep was touched nearer than 30 yd., and then a sheep was killed in a direct line with each of the three holes made; the holes admitted a thin cane for 2 or 3 ft., but no exit was noticeable; the sheep evidently were those standing exactly over the line taken by the lightning. Means of defending animals lying out are therefore difficult to devise; and there seems to be a special risk in placing animals in hovels or sheds standing in fields. The oak is the most frequently struck tree, and ash and elm are not rarely struck; the beech is the least often struck, and this suggests that it is the best to plant for shelter in pastures. Most fire insurance companies now include the loss by lightning in their policies, although few did it until within recent years. Farmers should see that compensation for loss from lightning is secured to them. [W. J. M.]

Lightning—Damage to Woodlands.—Lightning often strikes trees, and may kill them outright; but the total amount of damage done in woodlands is very slight, and the forester can do nothing to prevent it. In close-canopied woods the highest and most conically-shaped trees, such as Oak, Spruce, Firs, and Pine, are more often struck than others having a more rounded crown, like Beech; and of course from their isolated position trees in parks, avenues, fields, and hedgerows are more likely to be struck than trees in woodlands. Sometimes the tree struck is split right down, or even splintered, but in most cases a lightning-struck tree merely shows a wound of about 1 in. broad in the bark and following the run of the stem-fibres, so that there is a spiral mark on stems of twisted growth (*e.g.* many Horse-chestnuts). Lightning-struck conifers soon die, while in Oak and other broad-leaved trees the wound sometimes gradually cicatrizes or else the tree sheds its bark almost entirely. In the woodlands lightning has been seen to spring from tree to tree; and in pine woods, when a tree has been struck and killed, many apparently uninjured trees round about it gradually sicken and die. Lightning may set fire to trees that are dry and rotten inside, but there is no practical danger of forest fires being caused by lightning. [J. N.]

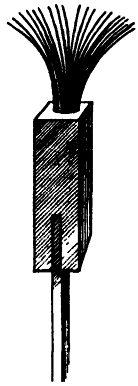


Fig. 1.—Brush Points of Lightning Conductor

Lightning, Protection from.—Following up Benjamin Franklin's success in discovering that electricity might be conducted from the clouds to the earth and so rendered harmless, and also that by the use of a non-conductor the conducting medium might be held in place without injury to materials to which the conductor is attached, systematically designed lightning conductors have been contrived to minimize the risk of injury when the clouds are highly charged with electricity, as during a thunderstorm. It would be claiming too much to say that buildings are made absolutely lightning proof, as sometimes the charge is so great that the systems employed are incapable of conducting the whole of it; but a considerable degree of security can be assured by well-devised conductors. The

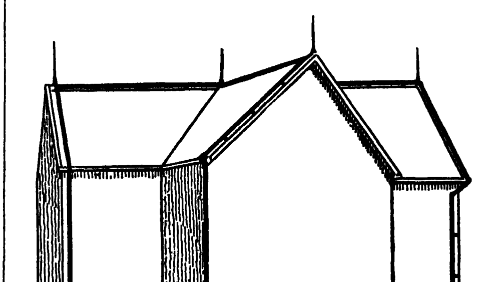


Fig. 2.—Adjustment of Lightning Rods on Barn

ordinary lightning conductor tends to safety by preventing the accumulation of electricity in the clouds, as it gradually carries it away; but this may not be sufficient, and then a more complete system of conductors is necessary to

protect a building. This is best effected by running conductors—copper ribbons $\frac{3}{4}$ in. by $\frac{1}{8}$ in.—along the ridge, with standards not less than 6 ft. higher than the building nor more than 40 ft. apart, and carrying these down into the ground at each gable end. The copper must be carefully insulated from the building, and be grounded several feet deep in moist earth, and be attached to a ground plate of copper of at least 24 sq. ft.; an old copper boiler flattened out is effective. Right-angle turns should be avoided, and thorough insulation be assured, or lightning may be drawn to the building it is desired to save. [W. J. M.]

Lightning Shock.—The nervous system is most affected by lightning shock, and those nerves governing motion in particular. An animal may be so paralysed as to be unable to rise from the ground, yet capable of grazing round the spot, and if a ruminant, of chewing the cud. The shock may be confined to a small area and produce paralysis of the muscles on one side of the face; the animal may have pendulous lips and distorted countenance, or a wry neck, or single limb incapacitated, or may remain temporarily blind. In other cases, where the body is struck, a very superficial examination suffices to trace the current, as though a red-hot iron had been drawn over the skin; and under it the blood is like jelly, mixed with effused fluid. Shocks severe enough to destroy life at the time leave the blood fluid and non-coagulable, and disposed to rapid decomposition. There is a disposition to recover from lightning shock, and it is doubtful if any treatment is of value. It is, however, important that stock-owners should see that their insurance policies include this frequent source of loss, and that they are not ruled out as 'acts of God', together with 'civil commotion, foreign invasion', &c., and no time should be lost in obtaining the certificate of a veterinary surgeon. [H. L.]

Light Sash.—These should be substantially made, but at the same time the centre bars for the support of the glass must not be too thick, or they will be harmful in intercepting sunshine from the plants beneath. The woodwork of the frame may be $1\frac{1}{2}$ in. thick and $2\frac{1}{2}$ in. broad, and the bars 1 in. broad and $1\frac{1}{2}$ in. thick. Somewhat large panes of glass are preferable to the very small ones which were formerly used. An iron handle should be affixed to aid in opening and shutting the sashes, and those of large size require a cross bar of iron to strengthen them. Three coats of white or lead-coloured paint should be applied in the first instance to preserve the wood, and an annual repainting is advisable. [W. W.]

Lights on Vehicles Act.—By the Lights on Vehicles Act, 1907, it is provided that every person who shall cause or permit any vehicle to be in any street, highway, or road to which the public have access during the period between one hour after sunset and one hour before sunrise, shall provide such vehicle with a lamp or lamps in proper working order, and so constructed and capable of being so attached as when lighted to display to the front a white light visible for a reasonable distance. If only one lamp is provided, it shall be placed on the off or right side of the vehicle; and if the lamps are so constructed as to permit a light to be seen from the rear, that light shall be red. If the vehicle is used for the purpose of carrying timber or any load projecting more than 6 ft. to the rear, a lamp or lamps in proper working order must be provided, so constructed and capable of being so attached as when lighted to display to the rear a red light visible for a reasonable distance. The person in charge of the vehicle in any street, &c., to which the public have access during the period above mentioned, shall keep the lamps properly trimmed, lighted, and attached. Failure to conform with the provisions of the statute involves penalties not exceeding forty shillings for a first offence, or five pounds for a second or subsequent conviction. A person in charge of a vehicle, who is charged with an offence under the Act, is not liable to conviction if he proves to the satisfaction of the court that the offence arose through the neglect or fault of some other person whose duty it was to provide the vehicle with a lamp or lamps. The council of any borough may, by order approved by the Secretary of State, exempt from the operations of the Act, subject to the provisions of the Act as to notice, &c., a vehicle carrying inflammable goods, or a vehicle within any place in which it would be dangerous to enforce the provisions of the Act owing to the fact that inflammable goods are usually stored or dealt with in or near the place. A County Council may by order exempt from the operations of the Act vehicles carrying in the course of harvesting operations any farm produce to stack or barn during such periods or months in the year as may be specified in the order, and such orders may be made to take effect throughout the whole county or in part of it only. The Act applies to every sort of vehicle except the following:—

(*a*) Any bicycle, tricycle, or velocipede to which the provisions of the Local Government Act of 1888 requiring lamps to be carried apply.

(*b*) Any light locomotive or motor car which is required to carry lamps under the Locomotive Act, 1896.

(*c*) Any other locomotive required to carry lights under the Locomotive Act, 1865, or wagon drawn by that locomotive.

(*d*) Any vehicle drawn or propelled by hand.

The Act applies to any machine or implement of any kind drawn by animal traction as it applies to vehicles. The Act does not apply to Scotland. [D. B.]

Lignin, Lignose, or **Lignone** is the name given to those substances produced in the change which cellulose undergoes during lignification, or its conversion into so-called woody fibre. The chemical characters and properties of the compounds formed are not well understood. They, however, give rise, on hydrolysis with acids and ferments, largely to furfurol, thus indicating the presence of furfuroids or pentose carbohydrates. The so-called crude fibre of coarse fodders and other feedingstuffs is relatively rich in lignocellulose. The digestibility and actual value of lignin as an animal foodstuff has not been

properly ascertained. Lignification is found in the older cell tissues of plants, in trees it is frequently coloured brown with tannin. Lignified cells can be easily identified by colour reactions. They become pink when treated with phloroglucin and hydrochloric acid, and stain a yellow with aniline dyes. [R. A. B.]

Ligustrum, a genus of hardy, evergreen or deciduous shrubs or small trees (nat. ord. Oleaceæ), comprising about twenty-five species and widely distributed, a number being natives of China and Japan. The flowers are usually white, and are borne in terminal panicles, in some species comparable to those of Lilac. *L. ovalifolium* (Japan, Oval-leaved Privet) and its golden variety are among the most valuable of shrubs, and as they stand smoke well, particularly so for town gardens. *L. vulgare* (Common Privet), a native of Britain, bears clipping and the drip from overhanging trees equally well, but its leaves are smaller and not so persistent as those of *L. ovalifolium*. The black berries of *L. vulgare* are used in dyeing, and the wood, which is very hard, by turners, and by shoemakers for making pegs. Being of a very close habit, Privet is one of the best of hedge plants. The following is a selection of species which are less common but more ornamental than the preceding: *L. Ibota*, deciduous, 6 to 8 ft.; *L. japonicum*, evergreen, 6 ft., a good seaside plant; *L. lucidum*, 10 ft., large evergreen leaves; and *L. sinense*, 20 ft., forming a small tree, sub-evergreen leaves, and producing an abundance of white flowers in July. Privets are not particular as to soil, but where rapid growth is desired pains should be taken to make it good. They are easily propagated by cuttings inserted in the open ground. The rarer sorts may be increased by grafting on the more common kinds. [W. W.]

Liliaceæ is the botanical name for a natural order of monocotyledonous plants distinguished by the following characters: (1) the envelope (perianth) of the flower is composed of six brightly coloured segments; (2) the stamens are six in number; (3) the ovary is three-chambered and superior. The order is extensive, and for convenience is divided into three sub-orders by the character of the fruit.

Sub-order 1.—The fruit is a capsule with one style. Examples are: Lily, Hyacinth, onions, leeks, and garlic, tulips, &c. The Aloe is a tree-like member of this sub-order which grows in Africa.

Sub-order 2.—The fruit is a capsule with three styles. Meadow Saffron or Autumn Crocus (*Colchicum autumnale*) belongs to this sub-order and is a poisonous corm-bearing perennial of moist rich pastures.

Sub-order 3.—The fruit is a berry. Examples are Asparagus, Butcher's Broom (Ruscus), Lily of the Valley, Solomon's Seal, Dragon tree (Dracæna), and Sarsaparilla.

It is noteworthy that many Liliaceæ are more or less poisonous, *e.g.* Tulip, Meadow Saffron, Lily of the Valley, &c.

All British Liliaceæ are herbs, except Butcher's Broom, which is a shrub. Some foreign representatives are trees: Dracæna, for example, is one of the tree Liliaceæ, having a stem which increases in circumference. [A. N. M'A.]

Lilium (Lilies).—This genus (nat. ord. Liliaceæ) comprises a large number of species of hardy, half-hardy, and greenhouse bulbs, natives of the northern temperate regions, the most beautiful species hitherto discovered being natives of Japan, China, and Burma. The large, handsome, fragrant and variously coloured flowers make them perhaps the most valuable of all bulbous plants, and an increasing amount of attention is being devoted to their cultivation in a variety of ways. Indeed their field cultivation in Japan and Bermuda for the European and American markets is conducted upon an enormous scale, millions of bulbs being exported annually. These imported bulbs are, however, generally but shortlived, and it has been suggested that better results might be obtained from lilies raised from seeds in the warmer parts of Britain. Lilies have a variety of uses in the garden. Under glass they are forced to provide white flowers for the great church festivals; they are valuable as decorative plants in the conservatory, and give splendid results when left undisturbed in the borders of a cool house. Out-of-doors they are generally placed in the mixed border, but they are particularly effective in beds of rhododendrons, while some species are very suitable for the rock garden, and beautiful effects may be obtained by naturalizing the more robust kinds. It must be said that lilies sometimes give but disappointing results For one thing, their soil requirements are so varied that a number of conditions, and some understanding of what the different species require, is needed for success with a collection of lilies. Some will thrive in any sort of soil, others need peat and sand, while others prefer a rich soil. A little protection from severe frost is generally advisable, and as very bright sunshine causes the stems to wilt, it is best to plant them in partial shade.

Early autumn is the best time to plant lilies, strict attention to this particular being most essential with those kinds, such as the Martagons, which only send out roots from the base of the bulb; the others may also be planted during the spring. For cultivation in pots a compost of turfy loam, peat, and sand is the best. The pots should be plunged in ashes out-of-doors or in a cold frame until root action is well advanced. They are next taken into a greenhouse of moderate temperature, where they must not be unduly forced until the buds are visible. After flowering, the bulbs are left in the pots in a cool shady place until the foliage has quite died down. The following is merely a small selection from the large number of beautiful garden lilies: *L. auratum* (Golden-rayed Lily of Japan) and varieties; *L. Browni*, immense flowers, pure-white inside and reddish-brown outside; *L. bulbiferum*, red flowers; *L. candidum*, the white Madonna Lily of cottage gardens; *L. elegans* (*Thunbergianum*) and varieties, dwarf and early-flowering, very desirable; *L. Henryi*, a Chinese species of recent introduction with rich-yellow flowers freely produced; *L. Krameri*, pink flowers; *L. longiflorum*, and

var. *Harrisii*, Bermuda Lily; *L. speciosum* and varieties; and *L. tigrinum*, Tiger Lily. Several plants familiarly termed lilies, such as the Arum Lily (*Richardia*) and Lily of the Valley (*Convallaria*), are not true lilies. [W. W.]

Lily of the Nile.—The familiar white Lily of the Nile, Arum Lily, or Calla (*Richardia æthiopica*, nat. ord. Aroideæ, and not a lily in the true sense of the word), is one of the very best of greenhouse plants, and is grown for market on a prodigious scale, the plants being so managed as to flower most profusely at the time of the great church festivals. It was introduced in 1731 from Africa, where it is widely distributed and very abundant in marshy places. It is best suited by a compost of rich loam and cow manure in nearly equal parts. The plants are usually put out-of-doors during the summer months; we prefer to plant them and keep them in vigorous growth by abundant watering, but resting the rhizomes for a time by allowing the foliage to die down through dryness is an alternative plan. *R. Rehmannii* has pinkish-white flowers, while those of *R. Elliottiana* and *R. Pentlandii* are clear golden-yellow. These two species are of comparatively recent introduction. Several hybrids have been raised from them. Richardias are very readily propagated by means of suckers, preferably in the spring. [W. W.]

Lily of the Valley (*Convallaria majalis*, nat. ord. Liliaceæ), a widely distributed, hardy, herbaceous plant, with white fragrant flowers and delicate pale-green leaves, a native of Europe (Britain), North Asia, and the United States. It flowers outdoors in May and June, preferring a moist, shady situation, and a soil enriched with plenty of leaf mould or well-rotted manure. This plant and its varieties are very largely forced for the production of cut flowers in winter, the crowns, which have been specially prepared, being imported from Germany. They are planted thickly in a little light soil or cocoanut fibre with bottom heat, and are kept damp and well-moistened. If severely forced the crowns are of little further use, but those of later batches may be planted in the open ground. Propagation is usually by division, but it may be from seeds. It is advisable to divide large clumps. See also CONVALLARIA. [W. W.]

Limbourg Cheese.—This variety of cheese is made in two qualities, from new milk and milk which has been skimmed, both in Belgium and Germany, more especially in Wurtemberg, Saxony, and Bavaria, and is chiefly consumed by the working classes, who appear to appreciate its strong flavour when spread upon their bread instead of butter. Belgian makers export large quantities to France—quantities, indeed, which amount to many millions. The cheese is known in parts of Belgium as Herve, from the name of a little town a few miles from Liège. In another part of Belgium it has another name, Ramadoux, the derivation being taken, as we understand, from the German word Rahm (cream). In Germany the word has been varied or corrupted, so that the name applied to it is sometimes Romatour or Réomatour, while in Bavaria it is known as Bavarois. It weighs some $2\frac{1}{4}$ lb. when made from milk which has been skimmed, while in size it is 6 in. square by 3 in. in thickness. This weight, however, applies only to Belgium, for in Germany it is 5 in. square by 2 in. in thickness when made from whole milk. This cheese, sometimes called 'Limburger' in the trade, can easily be recognized before it has been seen, by the somewhat disagreeable odour which it possesses, especially when made from unskimmed milk. A whole-milk cheese is not only rich in fat, owing to the process of manufacture and the milk, but it is full-flavoured, and is not so delicate on the palate nor so piquant as the various whole-milk soft cheeses of France. A Limburger of the true type, made from milk which has been skimmed, is ripened to the full, as in the case of some Camemberts, which are kept until they run for the special purpose of pleasing consumers among the working classes, who apparently prefer strength of flavour as in a running cheese which has been made from skim milk—Camembert though it be—to the milder flavour of the Coulommiers or the Brie. Indeed the Limbourg cheese is as repulsive to the English palate as to the English nose. The process of manufacture closely resembles that which we have described in relation to Livarot, but the ripening process is carried to a greater extreme with the special object we have named. Where dairy farmers in Belgium or Germany make butter in those provinces where Limbourg cheese is popular, they are able to realize a good profit during the season of its production; but it must be confessed that in this country at least we fear it would not be acceptable to the working man, although it is not only a useful food, but, owing to its flavour, which makes it go further, it is most economical where the working classes are compelled to make their earnings go as far as possible. [J. LO.]

Lime.—The term 'lime' in the strict sense means the oxide of calcium, CaO. It is also applied to calcium hydrate, $Ca(OH)_2$, and to calcium carbonate, $CaCO_3$. Calcium carbonate is sometimes called mild lime, while the oxide and hydrate, quicklime and slaked lime, are called caustic or alkaline lime.

Lime is one of the alkaline earths. Its compounds are found very widely distributed in nature. Its original occurrence in the earth's crust is in the silicates, of which so large a part of the crust is formed. From these, by a series of secondary changes it passes into carbonates, which are found very plentifully among the stratified rocks. Carbonate of lime is found in mass as chalk, limestone, and marble. It is found of all degrees of hardness, from soft friable chalks and marls to hard dense marbles and limestones. It is found both in the amorphous and crystalline forms. It is from carbonate of lime that practically all the lime used for agricultural and other purposes is derived. In addition to its plentiful occurrence as carbonate, lime is also found in nature in smaller quantity as sulphate and phosphate.

Quicklime or calcium oxide is obtained by heating calcium carbonate strongly. When this

is done the carbonate is decomposed with evolution of carbonic acid gas—

$$CaCO_3 = CaO + CO_2.$$

This is commonly done by burning limestone or chalk in a suitable furnace or kiln along with fuel. The resulting lime is known as quicklime, burnt lime, hot lime, or lime shells. The chalk or limestone used in the preparation of quicklime is never quite pure. It contains more or less siliceous matter, carbonate of magnesia, together with compounds of iron, alumina, sulphur, &c. See CHALK, LIMESTONE, and CALCIUM COMPOUNDS.

For the manufacture of certain kinds of cement, marls or limestones containing a considerable proportion of clayey matter are burned; but for the preparation of agricultural limes, the limestone or chalk used should be as pure as possible. The natural limestone and chalk rocks vary from almost pure calcium carbonate to rocks containing large percentages of impurities, such as sand and clay. A pure limestone may contain over 98 per cent of calcium carbonate, while impure rocks may contain only 60 per cent or even less. The limestones in use are derived from various geological formations, of which the principal are the Cretaceous, Jurassic, Carboniferous, and Devonian.

COMPOSITION OF LIMESTONE.—Many limestones contain considerable percentages of magnesium carbonate, and nearly all contain some of this constituent. In dolomites or magnesian limestones the carbonates of lime and magnesia are found together in equimolecular proportions. A typical dolomite thus contains 54·4 per cent of $CaCO_3$ and 45·6 per cent of $MgCO_3$. In nature magnesium carbonate is found in combination with calcium carbonate in all proportions, from mere traces to compounds in which the proportion of magnesium carbonate is much larger than that of calcium carbonate. Magnesian limestones are not suitable for the manufacture of agricultural lime, though a rock containing a limited percentage of magnesium carbonate is not objectionable.

The following table shows the analyses of a few limestones:—

	1	2	3	4
	per cent.	per cent	per cent.	per cent
[1] Lime	55·15	44·42	29·27	38·52
Magnesia	0·33	5·78	19·87	2·20
Iron oxide and alumina	0·18	3·65	0·96	3·35
Sulphuric acid	0·23	0·63	—	traces
Carbon dioxide	43·03	40·74	40·67	29·67
Silica	0·10	0·87	4·32	24·71
Organic matter, &c. (by difference)	0·98	3·91	4·91	1·55
	100·00	100·00	100·00	100·00
[1] Equal to carbonate of lime ...	98·48	79·32	52·27	68·79

Of the above, Sample 1 is a hard limestone of high purity. Sample 2 is a somewhat impure sample containing a considerable proportion of magnesia. It was from a well-known quarry, the rock from which is extensively burned for making lime. Sample 3 is a magnesian limestone. It contained a little iron pyrites, which is included under 'Organic matter, &c.'. Sample 4 is an inferior limestone containing much sand. All of these samples are from Scottish deposits.

In order to turn limestone into lime it has to be heated to a temperature of about 1000° C. If it is not sufficiently heated, either through the temperature of the kiln not being high enough, or through the stone not remaining long enough in the burning zone of the kiln, the carbon dioxide is not completely driven off, and the lime is said to be underburned. In such a case it contains hard pieces of unchanged carbonate of lime, especially in the centre of the lumps. On the other hand, if lime be heated much above 1000° C. it is said to be overburned. Overburned lime does not slake readily, and if badly overburned it is difficult to slake it at all. The skilled lime burner therefore regulates his kiln so that the temperature varies from about 950° C. to 1100° C.

LIMEKILNS.—A great many different kinds of limekilns are in use. In recent times great improvements have been effected in limekilns, and a good modern kiln is a far more efficient instrument than those which were used formerly. In old-fashioned kilns, many of which are still in use, only 2 to 3 parts of lime, or even less, are obtained for each part of coal burned. On the other hand, the best modern kilns give 5 or 6 parts of lime for each part of coal burned. The economy of lime-burning largely depends on the economy of fuel, though economy of labour is also of great importance.

In old-fashioned kilns there is great waste of heat, especially from the top of the kiln. In modern kilns various devices are used to prevent this waste of heat and to economize fuel. Many modern kilns are made of steel lined with a thick coating of firebrick.

Coal is the chief fuel used in limekilns, but some modern kilns are worked with other forms of fuel; in particular, many attempts have been made to work kilns with producer gas. In old kilns the coal and lime were mixed together in the kiln in alternate layers, while in many modern kilns the fuel is kept separate from the lime in firing chambers. In this way the lime is not mixed with the ash and waste of the coal, and is therefore obtained in a purer and cleaner state.

A good, well-burned sample of lime should take up water readily and slake quickly, easily, and completely. In slaking, the calcium oxide

combines with water and forms calcium hydrate. Pure, well-burned lime when slaked falls completely to a fine dry powder, with the evolution of a large amount of heat. The quality of lime can be to some extent judged by the readiness and completeness with which it slakes.

Composition of Lime.—The quality of lime depends upon the purity of the original stone as well as on correct burning. The impurities of the limestone are almost all found in the lime. Any carbonate of magnesia in the original limestone is turned into magnesia, in which form it is found in the lime. Sulphur is usually found in limestone in the form of sulphides; in the burning these are largely oxidized into sulphates. Any silica in the limestone is during burning caused to combine to a greater or less extent with lime, and is found in the lime, to a large extent at any rate, in the form of calcium silicates. Compounds of iron, alumina, and other metals which were present in the limestone are found in the lime. In addition to all these, burnt lime usually contains a little carbonate of lime. It is seldom that a limestone is so completely burned that it is quite free from carbonate. Even if the carbon dioxide is completely burned off in the heating zone of the kiln, a certain amount of reversion to carbonate takes place by the lime combining again with carbon dioxide in the cooler portions of the kiln before it is drawn off, and by its obtaining a little carbon dioxide from the air after it leaves the kiln.

High-quality limes contain over 90 per cent of calcium oxide, and good lime should contain over 80 per cent. It is now common for purchasers of lime for agricultural purposes to obtain a guarantee that the lime contains over 70 or over 75 per cent of calcium oxide or caustic lime. Purchasers of lime for agricultural purposes should buy it by quality, and should endeavour to obtain a guarantee of the percentage of caustic lime or calcium oxide which it contains.

Analysis of Lime.—Formerly analyses of lime for agricultural purposes were rarely made, and even yet lime is only occasionally tested by analysis. For agricultural and many other purposes it is not necessary to have a complete analysis of the lime made. All that is necessary in most cases is to have the percentage of caustic lime determined. Till recently, analyses of lime were usually made by determining the impurities by a conventional method, and assuming that what was left was lime. This method, which is still in use, is not only lengthy and therefore expensive, but also inaccurate. There is no difficulty, however, in rapidly and accurately making a direct determination of the caustic lime present in a sample of lime. Several different methods may be used for this purpose, of which the best known, perhaps, depends upon the extraction of the caustic lime with a solution of sugar.[1]

Ground Lime.—Ground lime, which has come into use extensively for agricultural purposes during the last ten years, consists of burnt lime which has been ground to a more or less fine powder. It should therefore have a composition quite similar to that of ordinary burnt lime, except that as it has been exposed to the air a little during the grinding and handling, it may contain slightly more carbonate owing to a little reversion. If ground lime is properly handled, however, the amount of this reversion is so slight as to be practically negligible.

It is more difficult to judge of the quality of lime in the form of ground lime than in the form of lime shells. A great deal of very inferior lime has been sold for agricultural purposes in this form during recent years. It is therefore the more necessary for purchasers to have a guarantee of a certain percentage of calcium oxide or caustic lime when they buy lime in this form. A good sample of ground lime should contain not less than 70 per cent of caustic lime. A large proportion of the samples analysed by the writer during the last few years have contained less than this. Samples containing under 50 per cent of caustic lime have been quite common, while occasionally samples were found containing under 40 and even under 30 per cent of caustic lime. It is therefore very necessary to have the quality of this kind of lime checked by analysis from time to time.

Hydrated Lime.—Hydrated lime consists of lime which has been slaked with just about the theoretically correct proportion of water, and then sifted through fine sieves to remove all coarse materials, such as impurities, pieces of imperfectly burnt lime, &c. It is usually sold in bags. It consists of a very fine dry powder, and is a convenient form in which to purchase lime for many purposes It consists essentially of calcium hydrate. In this case the manufacturer has slaked and sifted the lime, and got it ready for immediate use by the consumer.

The table on p. 76 gives the composition of a number of typical samples of lime of various kinds.

Sample No. 1 is a shell lime of high quality. No. 2 is a good sample, but contains appreciable quantities of a number of different impurities. Both of these are English limes. No. 3 is a shell lime of poor quality. It contained a considerable amount of siliceous matter, including silicate of lime and other impurities. Sample No. 4 is an excellent sample of Scotch ground lime. No. 5 is a good sample, and was prepared from English lime. No. 6 is a poor sample, though it is very much better than many of the samples received during the last few years. Sample No. 7 is a good sample of hydrated lime.

Uses of Lime.—Lime is used for a great variety of purposes. In agriculture it is chiefly used for application to the soil, but is also used in preparing insecticides and fungicides for spraying on plants, and for preparing lime washes or white washes for painting on walls, partitions, &c. In addition to its agricultural uses it is very extensively used in building in the preparation of mortars, cements, and plasters. It is used to purify coal gas, and the resulting material, gas lime, is commonly used for agricultural purposes. It is used in sewage

[1] See The Analyst, vol. xx, 1907: 'A Method of Estimating Caustic Lime by the Use of a Sugar Solution', by James Hendrick, B.Sc., F.I.C.

COMPOSITION OF COMMERCIAL LIMES

	Lime Shells.			Ground Lime.			Hydrated Lime.
	1	2	3	4	5	6	7
	per cent	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
Caustic lime (calcium oxide) ...	91·75	83·16	60·26	86·61	79·43	64·82	67·62
Lime in other forms	1·47	3·87	14·56	1·39	6·85	9·80	4·13
Magnesia	0·45	1·93	1·62	1·88	2·50	2·82	3·23
Iron oxide and alumina .	1·67	5·14	6·83	4·24	2·40	2·50	1·04
Sulphuric acid	0·18	1·32	3·07	0·08	1·30	1·90	1·62
Carbon dioxide, &c. (by difference)	1·75	1·38	4·77	1·08	3·04	6·37	1·90
Siliceous matter	2·73	3·20	8·89	4·72	4·48	11·79	1·35
Water of hydration	—	—	—	—	—	—	19·11
	100·00	100·00	100·00	100·00	100·00	100·00	100·00

precipitation, in water softening, in the manufacture of steel, bleaching powder, glass, paper, acetic acid, and a great number of other articles. Indeed it enters into use more or less in nearly all industries. See also LIMING. [J. H.]

Lime in Soils. See CALCIUM COMPOUNDS IN SOIL.

Lime Nitrogen is the popular name given to the new nitrogenous manure, calcium cyanamide. Its manufacture represents the first successful attempt on a commercial scale to utilize the free nitrogen of the atmosphere in the making of artificial nitrogenous manures. Many attempts had hitherto been made to tap the unlimited supply of free atmospheric nitrogen for manurial and other purposes, but all had proved a commercial failure. There are two methods of bringing free atmospheric nitrogen into a state of chemical combination. The first is by passing an electric spark through air. At the high temperature of the electric spark, nitrogen and oxygen gas combine together to form oxides of nitrogen which dissolve in water and ultimately produce nitric acid. The second method is based on the fact that when nitrogen is heated in contact with certain metals at a high temperature chemical combination results, with the formation of compounds which, on adding water, give rise to ammonia. Professor Frank and Dr. Caro of Berlin, making use of this principle, have invented a process the ultimate result of which is the production of lime nitrogen. They start with calcium carbide, the well-known substance used in the preparation of acetylene gas. The carbide is made by heating chalk and coke or some other carbon compound in an electric furnace. They found that when free nitrogen gas was passed over the carbide at a temperature about 900° C. chemical combination took place, with formation of the compound calcium cyanamide, $CaCN_2$. The reaction goes on in iron tubes containing the heated and finely ground carbide, and through which the nitrogen gas is passed until no more is absorbed. The free nitrogen gas is obtained by passing air over metallic copper heated to a temperature about 400° C., when the metal takes up the oxygen, forming oxide of copper, leaving the free nitrogen. The copper oxide is subsequently reduced by passing coal gas over the heated oxide. Nitrogen gas can also be obtained by distilling liquid air. The cyanamide is being manufactured by the Frank and Caro process at Piano d'Orte in Italy, this locality being chosen because of the cheap motive power—water power—obtainable for generating the electricity. The commercial success of the process almost entirely depends upon a cheap supply of electricity. In addition to the Italian works, factories for the manufacture of lime nitrogen are being erected in France, Canada, Norway, and Switzerland. The Frank and Caro process has been slightly modified by Dr. Polzeniuz. He adds calcium chloride to the carbide before passing over the nitrogen. The presence of the chloride helps the absorption of nitrogen. This modified method is being carried out by the North-western Cyanamide Company, Ltd., at Westeregeln, Germany. This manure is called nitrogen lime to distinguish it from the other make. The properties and manurial values of the two are practically alike. The term 'nitrolim' is used in recent advertisements to designate this manure. It is to be hoped, however, that this term will be dropped, as we already have a superabundance of terms with the prefix 'nitro' attached to them.

Lime nitrogen is a blackish, heavy powder, something like basic slag in appearance. It possesses a characteristic odour, due to the evolution of acetylene gas from small quantities of carbide present. It slowly reacts with water, producing chalk and ammonia gas, as in the following equation:—

$$CaCN_2 + 3H_2O = 2NH_3 + CaCO_3.$$

Moist air has the same result. When heated with superheated steam the same reaction goes on more violently. With acids it gets very hot and several nitrogen bodies are liberated, the principal being the dicyanamide. The salts of the cyanamide are similar to urea and ammonia, when combined with water, as showing in the following equations:—

$$\underset{\text{Cyanamide.}}{CN_2H_2} + H_2O = \underset{\text{Urea.}}{CON_2H_4}.$$

$$\underset{\text{Cyanamide.}}{CN_2H_2} + 3H_2O = \underset{\text{Carbonate of ammonia.}}{CO_3(NH_4)_2}.$$

The changes which lime nitrogen undergoes when added to the soil are not yet clearly understood. The reactions represented above

appear to take place. Löhnis has established the important and somewhat remarkable fact that most soils contain organisms capable of liberating the nitrogen as ammonia from this manure. As the decomposing action of water alone is slow, the availability of the nitrogen in lime nitrogen may largely be determined by the presence and rapidity of action of micro-organisms. It is certainly a fortunate provision of nature that organisms are found to exist in soils, capable of decomposing this compound. Löhnis has isolated two such organisms, to which he has given the name *Bacterium Kirchneri* and *B. Lipsiense*. Pure cultures of these bacteria are less effective in decomposing the manure than when growing together. Much obscurity still surrounds the changes which lime nitrogen undergoes in soils and the exact relationship of micro-organisms to these changes. Its manurial value, like sulphate of ammonia, ultimately depends upon the production of nitrate by nitrification of the ammonia. Löhnis states that the nitrogen in lime nitrogen is rapidly transformed into ammonia when the manure is applied to ordinary soils. Wagner states that its action in very sandy soils, peaty soils, and in soils deficient in lime is uncertain. The uncertainty of action may be due to the deficiency or absence of the decomposing organisms in the types of soils mentioned. Generally speaking, the availability of lime nitrogen as a manure is equal to that of sulphate of ammonia, and it can be applied in the same quantity and by the same method as the latter manure to crops. The manure contains about 20 per cent of caustic lime, which would be of much value where lime is deficient in the soil.

The average composition of lime nitrogen may be taken as follows:—

Calcium cyanamide	57 per cent.
Containing nitrogen	20 „
Caustic lime	21 „

Samples submitted to analysis at different times show a variation in the nitrogen content from 19 to 21 per cent. Its market value is about the same as that of sulphate of ammonia. In order to compare the unit value of nitrogen as lime nitrogen with other nitrogenous manures—say nitrate of soda—the following method should be adopted. Lime nitrogen on analysis contains 20 per cent of nitrogen and costs £11, 15*s.* per ton. Nitrate of soda on analysis contains 15·5 per cent of nitrogen and costs £9, 10*s.* To find price per unit divide the price per ton by the percentage of nitrogen, and the figures obtained will be the price per unit. In the example taken the price per unit of nitrogen in lime nitrogen is 11*s.* 9*d.*, and in nitrate of soda 12*s.* 3*d.*

Lime nitrogen is supplied in air-tight drums, because of its sensitiveness to moisture. As stated above, water liberates ammonia from the cyanamide, which unless absorbed would be lost. The manure should therefore be stored in dry places. In practice the manure should not be applied and left on the surface, but should be incorporated with the soil by ploughing or harrowing it in at once. In this way any loss of ammonia by volatilization would be avoided. Obviously the manure is not suitable for topdressing. Some experiments have shown that this manure, when applied at seeding time, has an injurious action upon the germinating seeds, and to prevent this the manure should be applied some weeks before seeding. More recent experiments have failed to establish similar results.

Lime nitrogen is in a very fine powder, with an unpleasant smell, and is disagreeable to handle. To get over this difficulty in practice it is recommended that the manure be mixed with damp earth previous to application. A. D. Hall has subjected the manure to practical tests with the purpose of ascertaining the effect of storage in a moist atmosphere in bags, and whether the manure can be safely mixed with superphosphate before application. In respect to storage in bags in ordinary manure sheds, he states that the manure will gradually slake, swell, and increase in weight, and suffer slight losses of ammonia, but under ordinary working conditions the losses will be inappreciable, and that the manure is no more difficult to store than any other artificial manure. There may be a little difference in the storage of nitrogen lime compared with lime nitrogen, as the latter contains calcium chloride, a very hygroscopic substance. In respect to its mixture with superphosphate, much heat is at first generated. To regulate that, water is sprinkled on during the mixing. Much of the superphosphate reverts through the action of the quicklime in the lime nitrogen, but there is no loss of citric acid soluble phosphate, or of ammonia. The resulting mixture is crumbly, and convenient to handle for sowing. The mixing should be done in a shed previous to application of the manure. Neutral or basic manures, except ammonia salts, can be mixed with lime nitrogen without any bother.

The results obtained in field experiments with this manure, when applied in drills to crops on ordinary soils, are equal to that of sulphate of ammonia. It may practically be said that wherever sulphate of ammonia is suitable as a manure, lime nitrogen is nearly as efficient. There is, however, this difference between the manures, that lime nitrogen contains 20 per cent of quicklime and sulphate of ammonia none. On soils deficient in lime the difference is an important one. In respect to lime nitrogen it should be mentioned that unfavourable results have been obtained on peaty soils, and its use on such soils is not recommended.

A report recently issued by the North-western Cyanamide Co., Ltd., contains a very comprehensive list of experiments which have been conducted in Great Britain and most of the European countries on a great variety of crops. The results establish the fact that this manure is a most important source of nitrogen for manurial purposes on most soils and crops.

[R. A. B.]

Lime-pans.—In calcareous soils it very frequently happens that, at a certain depth, a layer of the subsoil is found cemented into a

hard coherent mass which hinders the passage of water and the roots of plants. When the cementing substance is carbonate of lime the phenomenon is known as lime-pan. Lime-pans, like iron-pans (see art. IRON-PANS), are commonly the result of solution and subsequent re-deposition of the dissolved material, in this case carbonate of lime. This ingredient, which is readily soluble in water containing carbonic acid, is leached out of the surface soil, and is deposited in a deeper layer of the subsoil, at the top of the water-table, where the conditions of aeration favour the escape of the carbonic acid gas from solution. In the calcareous soils of arid regions, the formation of the pan may be due to the complete evaporation of the soil-water containing the dissolved carbonate. The water furnished by the rainfall penetrates to about the same depth each year, and on evaporation there gradually accumulates sufficient material for the formation of a pan. In other cases the carbonate of lime is brought up from below and deposited at the surface of the water-table. In extreme cases a rock-like mass of nodular limestone, as in the kankar soils of India, may be developed. Lime-pans may be removed by mechanical means, such as by breaking up the indurated layer with a subsoil plough; or the free passage of water through the pan may be re-established, except in bad cases, by the growth of plants with vigorous roots, like Burnet or Chicory. [T. H.]

Limestone.—Though other rocks may contain lime, the term 'limestone' is reserved for

Fig. 1 —Thin Section of Carboniferous Limestone seen under the microscope, showing foraminifera, fragments of shells and sea-lilies, and crystalline cement. × 12.[1]

those which are composed of carbonate of lime (calcium carbonate). The great majority of these have been formed from the hard parts of organisms, such as shell-fish, sea-urchins, coral-polypes, and the still humbler foraminifera, the remains of which have accumulated at the bottom of the waters in which they lived, and have in time formed solid rock (see arts. ARAGONITE and CALCITE). Both marine and freshwater limestones thus occur, the rock being made up of fossils, bound together by chemically deposited calcium carbonate. This cement in some cases was deposited from solution in the water while the shells were still accumulating at the bottom. In tropical waters, aragonite becomes laid down inorganically round small grains of sand, shell-fragments, and so forth, which may be rolled about by waves on the flanks of coral-reefs or at other spots rich in calcium carbonate. The little egg-like bodies thus produced are called *oolitic grains*; and, when cemented together in the course of time, they form the building-stones of uniform grain known as *oolitic limestones.* Other inorganic limestones may be formed on

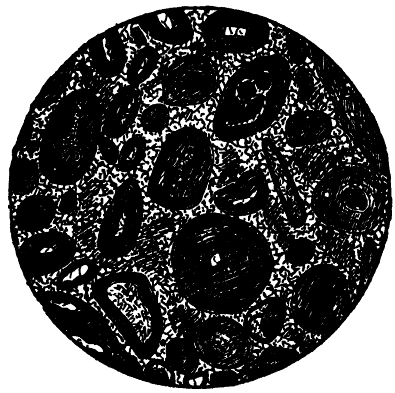


Fig. 2.—Thin Section of Jurassic Limestone seen under the microscope, showing oolitic grains and crystalline cement. × 12.[1]

land by deposition in encrusting layers from running water which contains calcium carbonate in solution (see art. CALCAREOUS TUFA).

The great bulk of limestones, then, are of marine origin, and abound in fossil remains. *Chalk* is a pure-white variety, largely composed of foraminifera. In the British Isles it forms a great part of our deposits of Cretaceous age. Oolitic limestones are common in the English Jurassic strata; massive grey limestone was deposited extensively in the whole British area in Carboniferous times. As we trace the deposits backward, limestones become scarcer. This is partly due to the action of solvent waters, which has removed beds of high antiquity; but it is probable that the animals of very early times were not commonly protected by calcareous shells. Massive limestones, now converted into crystalline marbles, occur, however, in pre-Cambrian formations, and some of these may have had an organic origin.

Compact limestones are traversed by convenient joints, and form useful building stones. Stone should be selected that is uniform throughout. If even thin seams of clay occur in it, these will stand out in time on the trimmed face of the stone as the calcareous part weathers away by solution in rainwater. Coarse fossils will similarly come to stand out upon the surface. Inspection of stones that have been lying a long time in the quarry is commonly advisable.

Many limestones contain some magnesium carbonate (see art. DOLOMITE), which does not

[1] Figs. 1 and 2 are taken from Cole's *Aids in Practical Geology* (Chas. Griffin & Co.). By permission.

seriously affect their characters unless they are required for the manufacture of cement. Hard flints have arisen in many limestones, forming nodules and bands running along lines of bedding. These often reduce the value of a quarry, but are sometimes useful as a rough road-metal, while the rock broken from round about them serves for lime. The purity of a limestone naturally influences its value when lime is required, and it may be cheaper in the end to import lime several miles by road than to burn a poor limestone, containing flints or silicates, on the spot. Since slaked lime soon passes into the form of carbonate when spread out and exposed to air, finely ground limestone has been employed direct upon the land.

Limestone is a very poor road-metal, though it is often used where other stone would involve a considerable initial outlay. There is no such thing as a hard limestone, though the term is often used by contractors; on the other hand, careful construction combined with steam-rolling will make a successful highway even out of limestone. Without rolling, the results are sure to be bad, and in the end extravagant as well as irritating.

Many altered limestones have become more distinctly crystalline; they have lost their original fossils and structures, and now form the rocks known as *marbles.*

Limestone in the mass often weathers out in scarps and plateaus, forming a terraced type of country, in which the grey rock of the cliffs alternates with grassy tables and with gentler cultivated slopes where more clayey beds come to the surface. In such a country, swallow-holes are common, formed by solution of the rock below; streams disappear into the ground, and reappear in distant places; and the farmer, working a quarry on the rock-face, may sometimes come across a great system of caves, dissolved out in former times by subterranean rivers. The flat surfaces of the rock, where bare of soil, show clear signs of solution, and sometimes deep grooves are worn down into them, such as those styled 'grikes' in Yorkshire. [G. A. J. C.]

LIMESTONE SOILS.—A limestone rock does not consist solely of carbonate of lime, but has always incorporated with it varying proportions of clayey or siliceous impurities. In the process of weathering, the carbonate goes into solution in water containing carbonic acid, and disappears into the natural drainage system, leaving a residue of the insoluble material behind. It is this earthy remnant, associated with some vegetable mould, and usually mixed with some partly weathered fragments of the rock itself, that constitutes the limestone soil with which the agriculturist has to deal. Sometimes, indeed, the soil contains no unweathered rock-fragments, and the leaching-out process is so thorough that the soils are left poorer in lime than others derived even from non-calcareous sources. A limestone soil will often present a remarkable contrast in colour and constitution with the rocky subsoil on which it rests.

Limestone soils are either clayey or loamy according to the nature of the impurities in the originating rock; they are usually thin and, from the rocky nature of the ground, unsuited to tillage. They, however, support short, sweet, nutritious pastures in which Sheep's Fescue, clovers, and other Leguminosæ are conspicuous. Some limestone rocks contain so little impurity that no soil gathers, and large areas of bare rock remain exposed. In other places a brown or red earth may be found washed down into hollows of the limestone land.

A good deal of the fertility of limestone soils is due to the occurrence of phosphates derived from the organisms that contributed to the formation of the original limestone rock. See arts. CARBONIFEROUS SYSTEM and CRETACEOUS SYSTEM. [T. H.]

Limestone Sheep—also called Limestone Cragg, Cragg, Horned Cragg, Farleton Knott, Warton Cragg sheep — are a breed of sheep which at one time pastured the rough limestone hills in South Westmorland, especially the two hills Farleton Knott and Warton Cragg, from which the two latter names are derived. In general appearance they resemble the Dorset Horned, but in detail they differ; it is possible, however, that the two breeds have originated from some remote prototype. The history of the Limestone sheep is somewhat obscure; they have, however, been bred pure through numerous decades, and have for many years been considered as a distinct breed. While the district around Burton and Holme in South Westmorland may be termed the 'home of the breed', they spread northwards to Hutton Roof and Brough and southwards, in limited numbers, to the Pennine range. A whitefaced hornless breed in Derbyshire called Limestones are in reality Leicesters.

The Limestone breed received considerable stimulus, and reached the height of its popularity during the middle part of the second half of the 19th century, due to the untiring efforts and spirited enthusiasm of Mr. Rowland Parker of Moss End, who might almost be termed the 'father of the flock', he and his father having kept the breed pure for over 100 years. They were the chief prizewinners at the Royal Agricultural Society's show, where separate classes were allotted to the breed up to and including the year 1889, after which they were discontinued. Partly owing to the abolition of these classes and partly to the fact that the sheep were slow to mature, interest in the breed waned, and there are now very few flocks left. These are much inbred, due to the limited numbers kept. Mr. W. J. Cornthwaite, Clawthorpe Hall, Burton, and Mr. H. Barber, Arnside, Carnforth, are the chief breeders. So far as is known, none have been imported, and there is no flock book.

They are a very hardy and active breed, well suited to the very rough limestone hills on which they are pastured, but do badly on soft land, probably owing to their susceptibility to foot-rot. When brought to dry inland pastures they fatten readily without extra food. They are noted for a preponderance of lean meat, and the local butchers are ready to pay top price for the few which still come on the market. The ewes

cross readily with other breeds, are very prolific, and make very good mothers if left alone; and although slow to mature, a large number may be kept on a given area. Why, with all these excellent qualities, has the breed dwindled? Firstly, as above mentioned, they were slow to mature; and secondly, although they crossed readily with other breeds, such crosses have not been attended with satisfactory results, at any rate in their home district, the half-breds being less hardy. Possibly the product of Limestone ewes and a Hampshire ram might do well in the Midlands.

The chief markets were Kendal and Milnthorpe, Preston being a good outlet for the heaviest animals.

CHARACTERISTICS.—Although bred through numerous decades, there appears to have been little or no change in type. As stated above, they resemble somewhat the Dorset Horned, but are not so close woolled. They have been known to have two crops of lambs, but do not, as has been erroneously stated by some writers, come in season at any time of the year. They are thick-set, active, and hardy, with good carriage.

Head.—Male and female horned. Horns strong in male, with a second curl when aged; much shorter and straighter in the female. Tuft of wool on forehead.

Ears.—Small, inclined slightly upwards, and are in front of the first curl of the horns.

Face.—Broad, white.

Neck.—Short.

Shoulders.—Slope upwards from the side and gradually blend with the ridge of the spinal column. This makes the sheep handle badly at this point, even when in good condition.

Breast.—Wide and well forward.

Body.—Thick-set, back fairly level but rising at the shoulder, under line straight.

Legs.—Pure-white, medium length.

Hind quarters.—Loin very good; legs give the idea of lightness; tail cut in both male and female.

Wool. —White, medium length, somewhat open, straight and shaggy, free from curl, good quality (has been known to fetch 1*d.* per lb. more than Lincoln wool sold at the same time). Weight of fleece, 5 to 9 lb.

Mutton.—Excellent quality, full of lean, making top price per pound.

Lambs average 12 to 15 lb., ewes 24 lb., shearling wethers 18 lb. per quarter. The average price in 1908—fat lambs, 30*s.*; shearling ewes, 40*s.*; shearling wethers, 45*s.*

MANAGEMENT OF THE FLOCK.—This is of the simplest nature possible. During December, January, February, and March they are kept on the enclosed fields of the farm; if snow comes, a little hay and roots are given. Lambs are dropped about the end of March or beginning of April, and formerly it was the custom to send both ewes and lambs to the hill pasture when the latter were a month old. Later, this practice was discontinued, and they are now kept on the lower land until the end of July, after which they are taken to the hill pasture, where they remain until brought down about the second week in October, the ram being turned to them about the third week in October.

Holt, writing under the heading 'Silverdale Breed' (Silverdale is a small village on the limestone stratum near the southern borders of Westmorland), in 1779, says: 'The Silverdale breed is found on the limestone hills near Silverdale; they are horned, white faced, and close woolled, are said to be native and much superior to the commoner kinds kept in the district both in fleece and carcase. In the townships of Burton and Holme, where these sheep are bred, the average clip for the 8 years 1772–1779 was 6 fleeces to 14 lb. wool. The flocks are owned by the landlord and let with the farm. Ewes brought to closed fields in winter and returned to the hills, after the lambs are dropped, at the end of April. The wethers are left to shift for themselves on the hills.' A footnote is added, 'probably Dorset Horned sheep bred in Westmorland'.

It is very probable that Holt was here describing the Limestone sheep, for firstly he mentions that they 'were bred at Burton and Holme'. Now this is the home of the Limestones. And secondly, Silverdale, Burton, and Holme parishes are one small area of limestone hills. This being the case, we notice the great improvement in the weight of the fleece, brought about between 1779 and 1889, and the accompanying loss in closeness, for Mr. Parker's flock averaged in 1889, 7 lb. per fleece. [T. M.]

Lime Tree, or **Linden** (Tilia), is the chief genus of the family Tiliaceæ, which consists mostly of trees and shrubs having alternate oblique leaves with deciduous stipules, a cymose and few-flowered inflorescence with a peduncle adnate to the leafy bract, hypogynous flowers with five green sepals, five separate light-green petals, and numerous stamens, and a coriaceous one-seeded and one-chambered nut. The European Lime tree is indigenous to Central and Southern Europe and Western Asia, and was introduced into Britain by the Romans; while several other species are found in the warmer temperate regions of Asia and North America. Originally classed by Linnæus as one species (*T. europæa*), the European Lime tree exhibits such constant and marked climatic differences as to constitute two well-defined varieties, if not actually distinct species. Both have cymose, yellowish-white flowers with scaleless petals, a coriaceous, downy, yellow nut fruit, and obliquely cordate, acuminate, serrated leaves. But the northern variety (*T. parvifolia*, syn. *T. cordata*) has smaller and smooth leaves, dark-green above and dull bluish-green below, with rusty reddish-brown hairs in the angles of the veins, and cymes with more than three flowers (often five or seven); while the southern (*T. grandifolia*, syn. *T. platyphyllos*) has larger leaves, bright-green above and downy-white below, and three-flowered cymes. But botanists now also distinguish an intermediate variety, which they call the Common Lime tree (*T. vulgaris*). The small-leaved northern kind, which forms extensive woods in East Prussia and Western Russia (often along with Oak and Elm), is hardy and thoroughly naturalized in Britain; whereas the large-leaved southern kind only ripens its fruits here in warm seasons. So far as British forestry is concerned, however, they may be treated as one species, cultivated almost entirely for ornamental purposes, and easily recognized by its characteristic bright-

LIMESTONE CRAGG RAM

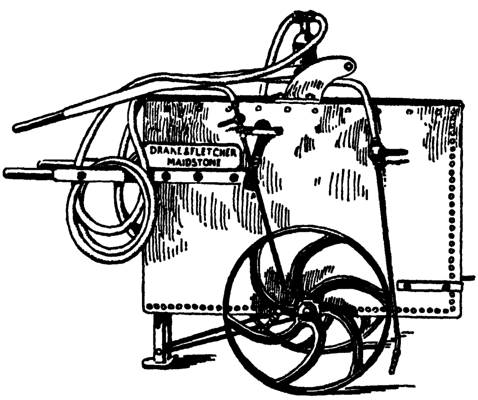
Photo. Chas. Reid

LONK RAM, "YOUNG KING"

FIRST PRIZE WINNER, R.A.S.E. SHOW, 1902

green foliage, its stalked yellowish-green flowers, and the three or four to eleven fruits rising from elongated tongue-like bracts, which the wind carries off with all the fruits attached. It forms beautiful avenues, although as a park tree it is somewhat stiff and formal in outline, remaining branching close to the ground, carrying a heavy oval crown of foliage, and often throwing out very numerous shoots from the base of its trunk. As an avenue tree it can remain sound for about 200 years, and it can grow to a height of 80 to 100 ft., with a girth up to 10 or 12 ft. Its finest ornamental effect is produced in July, when it is in full flower (honey bees become much attracted to them) and the foliage is at its best. It stands city smoke fairly well, and was formerly largely planted in town gardens and open spaces. Its wood is very light, close, white, and soft (sp. gr. 0·74 green, 0·45 seasoned); but it is not durable, and soon gets insect-bored even in dry places. On the Continent it is used for wood pulp, packing-cases, carving, piano making, and framework for veneered furniture; but here it is mostly used for turnery and piano sounding-boards. The Lime tree thrives best on a loamy soil and in a sheltered situation, though it grows fairly well on any deep soil not too poor and dry. The large-leaved kind is the handsomer tree in the warmer parts of Britain, while the small-leaved Lime is preferable in Scotland, in a smoky atmosphere, and on poor land. With a strong recuperative power both kinds stand transplanting even as large trees, and will stand coppicing, pollarding, and layering. But owing to the softness of their wood they are not often found in the underwoods, though they are fairly shade-enduring. In northern Germany it is sometimes used for underplanting Scots pine, and its wood is dyed and sold as imitation ebony. The small-leaved Lime can easily be raised from seed sown in drills in autumn (or mixed with sand or fine mould to be kept for spring sowing) and covered with about ½ in. of earth, and then set as one-year seedlings in the nursery lines till wanted for planting. Even if nipped by late frost, the damage is soon repaired by fresh shoots and foliage. [J. N.]

Lime-washing Machine.—Lime-washing machines are used to apply whitewash or lime solutions to buildings and fruit trees in the place of the lime brush more commonly used until recent years. These machines are vessels provided with a pump, outlet tube, and nozzle to force out the liquid in the form of a spray. They differ considerably in size. Some are made in knapsack form, others are portable and on runners, while others are on wheels. For casual use, to wash cow byres and other buildings, inexpensive material can be used; but where the machine is required for spraying fruit trees with other mixtures than lime, it is usual to provide copper tanks. The ordinary knapsack sprayer is frequently used; coarser nozzles than those used for potato spraying are advisable. Those made portable or on runners are made for use where the plants are so close together that a wheeled machine cannot be worked. As the lime is in suspension rather than solution it is important that means to keep the liquid well agitated be provided. For working among tall trees, brass extension pipes, or lighter bamboo extension rods, are advisable



Lime Washer

to ensure efficient work and prevent waste of material. [W. J. M.]

Lime Water is a solution of lime in water. It is prepared by shaking up slaked lime with water, allowing the insoluble matter to settle, and decanting off the clear liquid. It is an official pharmaceutical preparation, and according to the British Pharmacopœia is prepared by shaking 2 oz. of slaked lime with 1 gal. of distilled water. One fluid ounce should contain about ½ gr. of calcium oxide or lime, or 1 litre should contain a little over 1 grm. of lime. Lime is not very soluble in water, and is more soluble in cold than in hot water. At ordinary temperature 1000 parts of water are capable of dissolving about 1¼ part of lime. Lime water is alkaline in reaction, and is used for a variety of purposes as a mild alkaline solution. On exposure to the air the lime gradually combines with carbon dioxide gas to form calcium carbonate or chalk, $CaO + CO_2 = CaCO_3$. Lime water therefore gradually loses its strength owing to the precipitation of the lime in the form of chalk, and should be kept in tightly stoppered bottles or else made up fresh for use. It also loses strength on heating, as lime is less than half as soluble in boiling as in cold water. [J. H.]

Liming consists in applying lime to the soil. Lime is applied either as slaked lime, ground lime, or as carbonate of lime in the forms of chalk, marl, or ground limestone. Though all these practices are called liming, the terms 'chalking' and 'marling' are also used. In liming, the soil is supplied with lime which is available as a base. Practically that means with lime in the form of carbonate, for even if the lime is given in the form of quick or slaked lime this soon combines with carbon dioxide in the soil and is turned into carbonate of lime.

The amount of lime found in the soil varies very greatly. In some soils on chalk or limestone formations very large amounts of car-

bonate of lime are found. But in many soils the amount of lime in the form of carbonate, or other form in which it is available as a base, is very small, and in some it is practically absent. In most soils in Scotland the amount of carbonate of lime is small, and it is not uncommon to find less than 0·1 per cent present. Soils with over 1 per cent of carbonate of lime do not as a general rule require liming, but soils with only very small quantities of this constituent, such as occur over wide areas in Britain, require to be systematically limed. A soil should contain, as a rule, at least ½ per cent of carbonate of lime if it is to be maintained in the most fertile condition. Even this small proportion of lime means a considerable amount in the soil of an acre of land. In a good agricultural loam there are about 3,000,000 lb. soil per acre to a depth of 9 in. Even 0·1 per cent of this would mean 3000 lb., or nearly 27 cwt., so that 0·5 per cent of carbonate of lime would mean 15,000 lb., or over 6½ tons, per acre to a depth of 9 in. Soils, therefore, which contain 5 or 10 per cent of carbonate of lime contain enormous stores of this constituent. On the other hand, a heavy liming, such as 3 or 4 tons of lime per acre, does not add more than a fraction of 1 per cent of lime to the soil.

The practice of liming is an ancient one. Formerly lime and dung were practically the only manures at the disposal of the farmer, and probably better use was made of both by a former generation than by the present one. Liming was carried on very extensively in the first half of the 19th century; but after the introduction to general use of artificial manures the use of lime greatly decreased, and during the past thirty years the lime used in Britain for agricultural purposes was probably only a small fraction of that used in any other like period of the 19th century. To a large extent the present generation has been living on the capital laid up in the soil in the form of lime by former generations, and in many cases this capital is now exhausted or nearing exhaustion. It is curious that while practical farmers continue, very properly, to look upon dung as the basis of their manuring, they have lost to a very large extent the regard which their predecessors had for the almost equally important practice of liming. Formerly lime in the form of marl, chalk, shell-sand, and burnt lime was most extensively used all over the country. Now, traditional practice in regard to liming has been so far forgotten, that many farmers look upon a recommendation to use carbonate of lime on the soil as something new, and only use burnt lime by the hundredweight where it was once used by the ton.

The part which lime plays in the soil has already been dealt with (see CALCIUM COMPOUNDS IN SOIL). Nitrogenous, phosphatic, and potassic manures are used primarily to supply the plant with nitrogen, phosphoric acid, and potash. If they are needed, immediate increase of crop may be expected to result from their use. If nitrate of soda does not give an immediate increase of crop it is waste of money to use it. It is quite otherwise with lime. The chief use of lime in the soil is not to supply the plant with calcium, but to act upon the soil itself. Its effects upon the crop are chiefly secondary. It improves the crop by improving the soil, enabling other manures to act better, and keeping down certain pests which in the absence of lime are apt to flourish. Probably it is largely because the effects of lime on the crop are secondary that the practice of liming has diminished to so great an extent. As farmers have become accustomed to concentrated manures, they have come to look for great and immediate effects from the manures which they purchase. They expect to see at once, as the result of their expenditure, benefits which they can measure by the eye. In this they are often disappointed in the case of lime. Very frequently there is little or no direct increase of crop from the use of lime. Lime used by itself may even decrease crop. This is referred to in some of the old saws concerning lime, such as

> 'Lime and lime without manure
> Makes the farm and farmer poor'.

Lime acts by sweetening the soil, by promoting nitrification and thus enabling nitrogenous manures to act, by keeping pests in check, and generally by improving the conditions rather than by directly feeding the plant. The results of its action, therefore, should not be looked for in, nor measured by, direct increase of crop from the application of lime alone. Many experimenters with lime, as well as practical farmers, have gone seriously astray in this respect.

If liming is not resorted to, the supply of available lime in the soil gradually becomes exhausted. The amount of lime removed in crops is, generally speaking, small, and what is removed in this way from the soil is not serious. Deficiency in available lime in the soil will be shown in a serious manner otherwise, long before the crop will suffer from any direct want of lime. The chief loss of lime from the soil is in the drainage. When the soil is well supplied with lime, the principal base removed in the drainage water is lime. The amount of lime taken from the soil in this way is many times greater than that removed by crops (see CALCIUM COMPOUNDS IN SOIL). In order to make good this loss, lime in some form must be applied, or the soil will gradually get into an unhealthy state, diseases like finger-and-toe in turnips will become prevalent, and weeds which love a sourish or lime-free soil will increase. It is commonly said that finger-and-toe, that terrible pest of the turnip grower, has increased greatly during the last generation. This increase is probably intimately connected with the great decrease in the practice of liming.

There is a common idea that the use of artificials does away with the necessity for liming. This is a fallacy. The use in particular of sulphate of ammonia and dissolved manures like superphosphate increases the necessity for liming, for these manures use up the available base of the soil. On the other hand, basic slag, bone meal, and nitrates supply a little available base to the soil, and so far delay the exhaustion of lime. But several hundredweights of any one

of these are required to supply as much base to the soil as is supplied by a single hundredweight of good lime. Their effect, therefore, as lime suppliers is only very limited.

Formerly it was the practice to supply lime in large dressings at long intervals. When burnt lime was used, dressings of from 2 to 4 tons per acre were given. The lime was usually slaked in some way before being distributed. Such a dressing was usually given once only in the course of a considerable period of years such as a nineteen years' lease. Since the introduction of ground lime it has become the practice to give much smaller dressings and to give them oftener. Dressings such as 10 cwt. of ground lime are now quite common.

It is by no means necessary, however, to apply lime in the burnt or quick state whether as slaked or as ground lime. Carbonate of lime, that is lime in the unburnt state, may be used. Formerly carbonate of lime in soft and easily powdered forms, such as chalk, marl, and shell-sand, was often applied, and sometimes in very great quantities, amounting to many tons per acre. It is probable that the practice of applying burnt lime arose in part from the necessity of getting lime into the state of powder for distribution. In many parts of the country, soft and powdery forms of carbonate of lime are not to be had. Nowadays, with the improvement of machinery, it is possible to grind even the hardest limestones to powder, but formerly it was not so. Limestones were first burnt and then slaked in order to get them into a fine state for distribution.

In many cases, at any rate, the first effect of a heavy dressing of caustic lime is a harmful one, and probably where carbonate of lime in the form of powder can be obtained it will often be found safer to apply lime in this form than as caustic lime. The whole of this subject requires reinvestigation in the light of modern knowledge.

Caustic lime, whether as ground lime or as slaked lime, will probably always be specially useful in certain cases. On heavy clay soils it is useful in coagulating, and thus opening up and ameliorating the clay. It is probably also more active and effective than carbonate of lime in bringing about such chemical changes in the soil as result in the liberation of plant food held in very insoluble and unavailable states. But as a base in the soil to cure acidity and promote nitrification, carbonate of lime appears to be, weight for weight of lime, at least as effective as caustic lime. The first effect of caustic lime is to check nitrification, and it is only when it has been reverted in the soil into carbonate that nitrification again takes place with renewed vigour. The action of lime in the soil is very complicated, but it is safe to state that for most purposes it will be as effective if applied in the form of carbonate as if applied in the caustic form.

Carbonate of lime is now to be had not only as of old, as chalk, marl, and shell-sand, but as ground limestone. Only a few experiments have as yet been made with ground limestone in this country, but so far as these go they indicate that this is a quite useful form in which to apply lime. Weight for weight of lime also, it is, when near the place of production, cheaper than burnt lime. Roughly speaking, it requires 1¾ ton of carbonate of lime to supply as much lime as 1 ton of burnt lime. For equal amounts of lime, therefore, the cost of carriage is greater on ground limestone or any other form of carbonate of lime than on quicklime. On the other hand, it is cheaper to grind the limestone to a fine powder than to burn it to quicklime.

Ground limestone and other forms of carbonate of lime have the advantage over quicklime that they do not alter on exposure to the air. They can be stored in bags even in a damp place without swelling up and bursting the bags. They can therefore be held over from one season to another, should that be necessary, without risk of deterioration. On the other hand, ground lime if stored for any length of time is apt to absorb moisture from the air and swell up and burst the bags. It is probable that ground limestone will come into much more extensive use in the near future.

[J. H.]

In view of the numerous demonstrations that have been given in recent years of the superior efficacy of applications of basic slag as a means of improving poor permanent pasture, it seems probable that the practice formerly widely prevalent of applying lime to mountain and moorland pastures as the best means of improving them, will now be almost entirely abandoned. The effects produced by lime in 'sweetening' the pasture, in causing the disappearance of rough and coarse plants, and in promoting the growth of white clover and of finer and more nutritive grasses, have all been shown to be produced more rapidly and in a more marked degree by basic slag; and as the supply of this manure exceeds the demand, and as it can be applied with much less labour and at less cost than the heavier dressings of lime required, its general substitution for lime for this purpose may be considered certain.

On arable land, however, the employment of lime is perhaps more likely to increase than to diminish, and the questions of the quantities to be given, and of the proper times and methods of application, are of much practical importance. The older practice was to apply lime in quantities seldom less than 3 or 4 tons, and rising up to 8 tons or even more per acre. In recent times the practice has grown of applying the lime in a ground form in small dressings of about 10 cwt. per acre usually to the turnip crop. In the case of the ordinary artificial manures, the practice of giving them frequently in small quantities rather than in larger quantities at longer intervals has been proved by numerous experiments to be distinctly superior. But, as has been pointed out in a preceding section of this article, lime ought not to be regarded so much as a manure for particular crops, but rather as a substance added for the amelioration and improvement of the general character of the soil; and where, as on very stiff clays, or even on light sands, an improvement of the texture of the soil is one of the special benefits

desired, it is clear that this improvement can only be effected by the application of a sufficiently large dressing, and that occasional small dressings would either fail entirely to produce the desired effect, or that they would do so only after a long interval of time. On lands full of decaying vegetable matter and organic acids, such as peat and moss land, and newly drained and reclaimed swampy land, as well as on all soils in which lime is naturally deficient, it seems apparent that the best results will be obtained by applying the lime in the first instance in a sufficiently large quantity, which may be followed up in subsequent years by smaller and more frequent applications to replace the losses caused by drainage and other causes. For the prevention or cure of the 'finger-and-toe' disease in turnips, dressings of from 2 to 4 tons per acre are required (see art. on FINGER-AND-TOE), and the larger of these quantities would seem desirable, at any rate as a first application, on such soils as have just been described.

The common manner of putting such large dressings on the field has been to cart burnt lime from the kilns, to set it out at once in little heaps on the field at equal distances apart, and to leave the heaps untouched till they became gradually slaked by atmospheric moisture, and when the slaking process was completed, to spread the lime over the land as uniformly as possible with shovels. This method, which was formerly most generally adopted, has the great drawback that the lime is very imperfectly mixed with the soil. Through absorption of excess of moisture and of carbonic acid it is liable to become in great part caked into solid masses and lumps of variable size, and while these become finally buried in the soil they never become thoroughly intermingled with its particles. In experiments on 'finger-and-toe' at Woburn, Voelcker has found that the efficacy of various lime dressings turns very much on their being intimately intermixed with the soil; and there can be no doubt that the method of spreading lime from small heaps in the fields, of which only a small part might remain in a powdery condition, greatly detracts from the efficacy of the application. A much better method is to take the lime when it is brought from the kilns, and deposit it in one large heap with convenient access to water. The heap should be at once closely covered with a few inches of earth to exclude air, till it is convenient to apply the lime to the field. When that time comes, the heap should be opened out, and water should be brought and poured over it till it is all thoroughly slaked. It should then be left for about twelve hours, after which it should be turned over once more and passed through a riddle. Any lumps separated should be watered again, while the properly slaked lime will be found to have fallen into a very fine dry powder, which can be broadcast on the fields in any desired quantity by a manure-sowing machine. The sowing must, however, be done at once, as the lime, if left standing, quickly absorbs moisture from the atmosphere and becomes too damp and claggy to be capable of being well distributed or machine-sown. In trials conducted by direction of the writer at the West of Scotland Experiment Station, it was found that lime could be applied in this manner at a cost of about five shillings per ton less than ground lime, while it was also in a still finer state of subdivision than could be produced by grinding, and was therefore rendered more effective and more valuable.

Apart from the impossibility of distributing intimately throughout the soil lime that has been slaked in the common manner by exposure in small heaps in the field, it also undergoes chemical changes in the heaps which in certain circumstances considerably diminish the effectiveness of its action in the soil. The burnt or quick lime from the kilns, when put out in heaps in the field, consists of oxide of calcium, burnt or quick lime (CaO), from which the carbonic acid in the original carbonate of lime or limestone has been driven off by the burning in the kilns. This lime is caustic or burning in character. As the heaps absorb moisture from the atmosphere the oxide of calcium unites with water to form calcic hydrate or slaked lime (CaH_2O_2), which forms a fine powder, still caustic or burning in character. But the carbonic acid of the atmosphere at once begins to act on the calcic hydrate. It again unites with the calcium and restores it to its original form of carbonate of lime. Hence it has been found that by the time the whole heap on a field has become sufficiently slaked to be fit for spreading, it consists of a mixture of about 2 parts calcic hydrate, which is caustic, and 3 parts carbonate of lime (Johnstone and Cameron), which has been brought back to the mild, non-caustic, and less effective form in which it existed in the original limestone or chalk. Now on light and medium soils the lime in the mild form of the carbonate is perhaps to be preferred. But on peaty and mossy land, and on newly reclaimed land rich in organic matter, its action is distinctly less rapid than that of caustic lime, while on stiff clay soils the superiority of caustic lime is most strongly marked. The physical improvement of these soils, which is one of the most valuable benefits following on the application of lime, is chiefly due to the singular coagulating or curdling effect it produces on them. But this coagulation is only effected by caustic lime. Neither chalk nor any other form of carbonate of lime produces it; and if, therefore, the burnt lime be in great part restored to the form of carbonate before being applied to clay soils, a very large part of the advantage to be derived from its application is wholly lost. It is obvious, therefore, that the best as well as the most economical method of applying lime to these special classes of soils is to slake it in the large heaps and spread it immediately after slaking, and it is equally clear that neither ground limestone nor small dressings of ground lime will be suitable forms for these conditions.

In regard to the period in a rotation of crops at which lime should be put on the land, the most common practice perhaps is to spread it on the stubble in the autumn after a corn crop and before a green crop. This is a good practice,

in that it allows the lime to be well mixed with the soil during the tillage operations that are given in cleaning and preparing the land for the root crop; and on the stiffer clays in particular, on which the physical effects produced by the lime are of much importance, this practice may be considered as probably the best possible. In order, however, to secure the whole advantages of the causticity, the lime should be ploughed in without delay after it has been spread on the soil. Moreover, lime applied to the soil in autumn has some effect in diminishing the risks from 'finger-and-toe' disease in the succeeding turnip crop. The practice of applying small dressings of lime in the spring for this purpose is of little utility. But for the specific purpose of protecting the turnip crop against 'finger-and-toe' an application of lime some years earlier would be better. (See art. FINGER-AND-TOE.) On the whole, however, the best practice is to apply lime to the corn crop with which the grass and clover seeds are sown out, and this is the method recommended on all except the stiffest clays. The lime, in whatever form used, should be spread on the surface of the land after it has been ploughed, and may be applied either before the sowing of the corn or immediately afterwards. The nearer the lime is to the surface of a soil the better are its effects. Applied in this manner it covers the whole surface and is gradually washed down into and through the soil in the years of pasture, and is thoroughly mixed with it when the land is once more broken up. It has ample time to destroy the 'finger-and-toe' fungus before another turnip crop is grown, and it stimulates the growth of clovers and renders the pastures sweeter and more nutritive. It is also in this way removed from any direct contact with any crop on which the direct action of lime may not be wholly beneficial. Of these the potato crop is the most notable, for it has been well established that liming favours the occurrence of the fungoid disease known as 'scab' of potatoes. On the other hand, turnips on well-limed land are healthier and give a larger yield; while clovers, beans, peas, vetches, and indeed all leguminous crops, flourish best on soils that are rich in lime. For information on the duration of the effects of lime, see art. COMPENSATION FOR UNEXHAUSTED IMPROVEMENTS. [R. P. W.]

Limonite, the common oxide of iron combined with water, familiar as iron-rust, and often occurring as a brown product of decomposition on the surfaces of joints in rocks, even when these contain but little iron. At times it forms a massive mineral, dark-brown and fibrous, and orange-brown when powdered. Bog iron-ore is a variety. Almost all the brown tints of soils and of decomposing rocks are due to the formation of limonite from very various minerals, such as iron oxides, silicates, or sulphides. The chemical composition of limonite is expressed as $H_6Fe_4O_9$. [G. A. J. C.]

Limousine Cattle.—The steers of this important breed of France are much larger than the cows, owing chiefly to the fact that while the steers are taken from the mountains to rich pasture in the lowlands, where they obtain much better food, the cows are left behind and kept on poorer pasture for breeding and milking purposes. The well-fed Limousine expands under better treatment, and when fed for exhibition makes a favourable comparison with almost any other breed, as well in numbers as in size and quality. The breed has recently been improved, and has been crossed with the Shorthorn and the Charolais; although the former cross was excellent for the butcher, it diminished the aptitude for work, for the Limousine is a working beast. The breed is a hardy one, but yields poor returns for beef when fed solely in the mountains; but when fed as we have suggested, from the age of twelve to fifteen months, the steer makes a splendid carcass, which reaches from 66 to 69 per cent of the live weight of the animal. The colour of the coat is yellow, the shade being lighter on the inside portion of the limbs; the horns are also yellow and almost semicircular; the eyes are mild and large; the head of medium size, with a decidedly foreign expression; while the neck looks rather thick, corresponding to the remaining portion of the body, but this thickness is chiefly owing to the depth of the dewlap. Cattle of this breed are very docile, and slow in movement. The quarters are well proportioned, a well-fed animal carrying a large quantity of meat in the primest part; the thighs are well rounded, the flank is somewhat low, while the back is straight, if we allow for a slight depression in the centre; the ribs are fairly sprung, but the tail is higher than we like it in our English stock, while the slope from behind the loin is quite pronounced. Both oxen and cows are worked in the fields instead of horses, and although the cow shows the greatest energy she does not possess the same endurance as the ox, who seems to reserve his strength. Indeed the owners of the Limousine are known to use more cattle than are needed to draw a plough, with the object of preventing overworking, in order that he may produce better meat at an earlier period. [J. LO.]

Lincoln Long-wool Sheep.—The Lincoln Long-wool sheep are descended originally from the native sheep of the county, and are probably of the same origin as the Teeswater breed, as well as the Wensleydales. They have been greatly improved by crossbreeding with English Leicesters. They are known to have existed as an established breed in 1749 in the fen districts of the county. Youatt affirms that they are in all probability the parents of all our long-wool breeds in England. George Culley, a pupil of Bakewell's, describes them as follows in 1801: 'No horns, white faces, long, thin, and weak carcasses; the ewes weighing from 14 to 20 lb. a quarter; thick, rough, white legs, bones large, and wool long (10 to 18 in.), fleece of 14 to 18 lb.; slow-feeding, and mutton coarse-grained'. Culley, however, was strongly in favour of the Improved Leicesters, the great rivals of the Lincolns at that time.

Some of the best flocks have been in the hands of present-day breeders and their ancestors for considerably over a hundred years. The Royal Agricultural Society first specially recognized Lincolns in their prize list in 1862,

and previous to that time they were shown in the general long-wool classes. Lincoln breeders were slow to band themselves together, and it was not until 1891 that their association was formed under the presidency of Sir John Thorold, Bart. The first Lincoln Long-wool Sheep-breeders' Flock Book was issued in 1892.

The old Lincoln was a large, coarse, unwieldy animal, coming to maturity as a two-shear. They had clean heads and wrinkled faces. The modern Lincoln possesses much better flesh and form, while they have a distinct topknot, and less wrinkled faces. Lincolns, on the whole, breed true to colour, though jet-black lambs are not uncommon amongst the best long-wool flocks. This colour appears to be a recessive character, and often comes to the fore after use of certain rams.

Present Distribution in Britain.—Lincolns do best, and are found in the greatest perfection and numbers, in their native county, Lincolnshire. Perhaps the rich fertile pastures of the fens and the dry heath chalk soils are to some extent accountable for the immense size of the breed. Recently flocks of these sheep have extended into the counties of Nottingham, Leicester, Derby, and parts of Yorkshire.

Exportations.—Doubtless the export trade has done much to bring the Lincolns into greater prominence. They have proved themselves invaluable for crossing with many foreign breeds, especially with the Merino, and are extensively used for grading. Australia, New Zealand, and the Argentine are three countries where the Lincolns have proved of great service for grading up the home sheep, especially for purposes of wool production. Many also have been exported to France, Germany, South Africa, Russia, Spain, Canada, and the United States of America. The number of sheep exported by members of the Lincoln Long-wool Sheep-breeders' Association during 1907 was 3556 (2831 rams and ram lambs and 725 ewes and ewe lambs). The total number exported in 1906 was 6928, this being a record export in one year for any breed of sheep. In that year an entire flock, numbering nearly 1000, was exported to the Argentine. 4855 were exported in 1905.

Number in the Country.—By far the greatest number of sheep in the county of Lincoln are of this breed, where they are kept as pure long-wools or as pure-bred ewes for crossing with Down rams (Oxford, Hampshire, Suffolk, and Shropshire). About half a million sheep in the county of Lincoln are of this breed and pure-bred, and there are probably in addition about one hundred thousand of them in the neighbouring counties.

Points and Characteristics.—As its name implies, the Lincoln Long-wool breed is noted for the fleece. The animal is large, whitefaced, and hornless. The wool is very long—sometimes 20 inches in length—lustrous, and possesses a broad staple or lock. The beautiful gloss, wave, and nature of the fibre gives the Lincoln a unique position amongst wool-producing sheep. The clip from good Lincoln ewes sometimes reaches 14 lb. a fleece, and whole flocks clip a tod of 28 lb. from three fleeces. Ewe hoggs of good breeding will clip 14 lb. each, whilst two-shear rams have been known to give a two-stone fleece.

Standard Points.—As no detailed points of the breed have been published in England, the following are given from an American source:—

Scale of Points adopted by the National Lincoln Sheep-breeders' Association

	Points.
1. *Constitution.*—Body deep, back wide and straight; wide and full in the thigh, bright large eyes; skin soft and of a pink colour	25
2. *Size.*—Matured rams not less than 250 lb. when in good condition, matured ewes not less than 200 lb.	10
3. *Appearance.*—Good carriage and symmetry of form . .	10
4. *Body* well proportioned, good bone and length; broad hind quarters; legs standing well apart, breast wide and deep ..	15
5. *Head* should be covered with wool to the ears; tuft on forehead; eyes expressive; ears fair length, dotted or mottled in colour . .	10
6. *Neck.*—Medium length; good muscle, well set on body . . .	5
7. *Legs* broad and set well apart; good shape, colour white, but some black spots do not disqualify; woolled to the knees .	10
8. *Fleece* of even length and quality over body, not less than 8 in. long for one year's growth	10
9. *Quality of Wool.*—Rather fine, long wool; strong, lustrous fibre; no tendency to cot	5
Perfection	100

Though the mutton of the old Lincoln was always considered to be of a very fat character, it is now a good mutton sheep. Animals which have been well reared and fed from birth give carcasses full of lean meat. Some flocks, however, are better for this purpose than others.

Average Weights and Sizes.—*Ordinary Lincolns.*—On the average, the carcass weights of these are about as follows: Hoggs, 80 to 85 lb.; shearlings, 125 to 130 lb.; ewes, 120 to 135 lb.

Pedigree Lincolns.—A few years ago three winning Lincoln ewes at Smithfield, when killed, gave each 220 lb. carcass, this being 65 per cent of the live weight. A ram hogg from the same flock weighed 146 lb. when ten months old.

Recently the average value of the mutton has been about 5*d.* a lb. for fat old ewes, 6½*d.* to 7*d.* for wethers and shearlings, and 7*d.* to 7½*d.* for hoggs.

Flock Book and Pedigree Flocks.—The Lincoln flock book has been published each year since 1892. There are about 275 members of the association, and to each of these an ear marker is sent out annually to tattoo the registration numbers on the ears of the lambs. In 1907, 45,697 lambs were thus recorded as belonging to members. The following are a few of the more important flockowners: Henry Smith, Cropwell Butler, Notts; Henry Dudding, Riby Grove, Lincs; Dean & Sons, Dowsby Hall, Lincs; T. Casswell & Sons, Pointon, Lincs; J. E. Casswell, Laughton, Lincs; Sir John Thorold, Bart., Syston Hall, Lincs; T. Pears, Mere, Lincs; Harry Goodyear, Bourne, Lincs; Fred. Ward, Quarrington, Lincs. The secretary

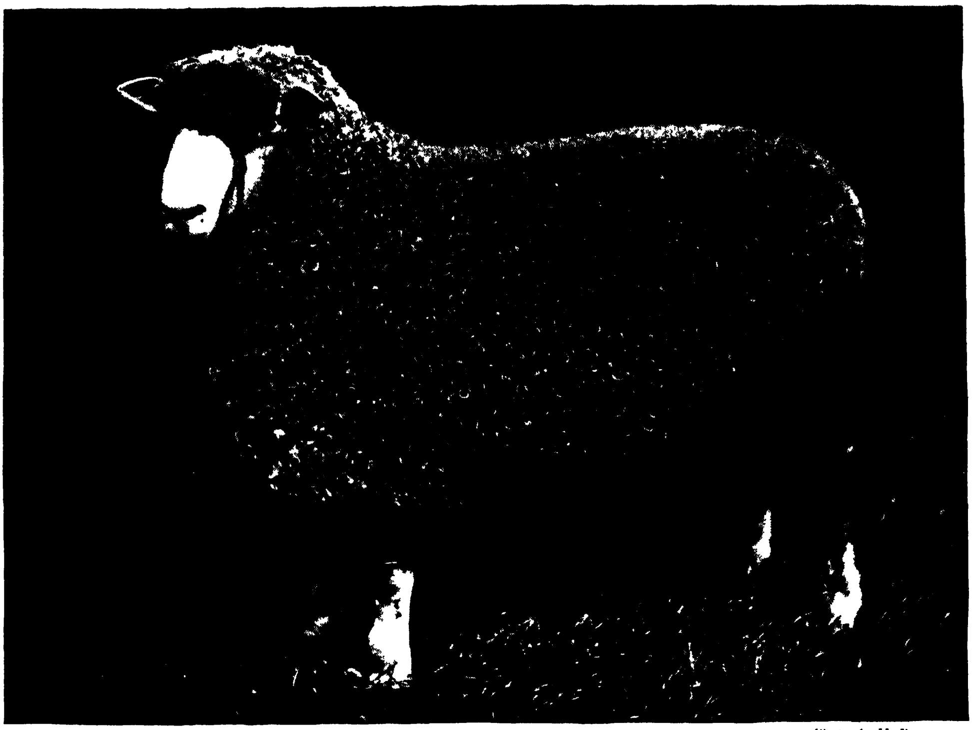


Photo. G. H. Parsons.

LINCOLN SHEARLING RAM—"RIBY GLOUCESTER CHAMPION"

FIRST AND CHAMPION AT THE R.A.S.E. AND LINCOLNSHIRE SHOWS, 1909

(129)

Photo. Chas. Reid.

LINCOLN EWE

ONE OF FIRST PRIZE PEN AT THE R.A.S.E. SHOW, 1908

of the association is Mr. William Frankish, St. Benedict's Square, Lincoln.

CHIEF MARKETS.—Two sales of Lincoln rams take place annually in connection with the association. These are both held in Lincoln, the first in July and the second in September. Many foreign buyers attend these sales, and it is at the first that most of the high-priced sheep are disposed of. The later September sale is the one at which farmers and local breeders select their rams.

Rams are also offered for sale at the fairs and at special auction sales held at Grantham, Sleaford, Newark, Nottingham, Lincoln, Boston, Spalding, Bourne, Peterborough, and other centres.

MANAGEMENT OF ORDINARY SHEEP FLOCK.—Young Lincoln ewes have recently been sold from 45*s.* to 60*s.* each. Gimmers have fetched from 50*s.* to 65*s.*, and rams anything from three guineas upwards. The rams are usually turned with the ewes in the first or second week of October—one ram to fifty ewes—so that lambing commences about the beginning of March. At the time of season ewes get rather better keep — known as flushing — to ensure a full crop of lambs. For this purpose mustard is frequently fed off by the ewes. About the middle of December, or earlier, the ewes are put on turnips — usually following the hoggs or fattening sheep — where they remain until February, within a few weeks of the lambing season. They are now taken off, put on grass, and given a little trough food. Ewes should be in good condition for lambing, though not overfat. As they approach lambing they are brought in to the lambing fold and moved forward as they lamb, getting mangels on grass, with a little mixed corn, cake, and chaff. The ewes may now be run upon new seeds until the pastures are forward. The young lambs are castrated and their tails docked when they are a week or two old, and are given an allowance of meal, corn, and cake until grass is plentiful. In some cases the concentrated food is continued, shutting off the ewes from the lamb troughs by creep hurdles. Both ewes and lambs are dipped between the middle of June and the middle of July, and weaning takes place at the end of the latter month. The ewes are now put on poorer keep to dry off their milk, and the lambs are given better food to compensate for the loss of it. Clover aftermath, with from ¼ to ½ lb. of cake (lamb food), takes them through August, when early cabbage is ready for them. Turnips follow, and they are fattened off on roots during the winter. The ewes are again dipped in November. The fat hoggs are sold from February onwards, while those still in store condition are run on grass and sold through the summer. The drafting of the ewes takes place about weaning time, when old and marked ewes are weeded out and gimmers put in their places. These crones or culls are put on mustard and rape, or are fattened on grass, unless they are sold as draft ewes.

PEDIGREE FLOCKS.—The treatment of well-bred Lincoln sheep differs from the ordinary treatment in that greater care is exercised in drafting the flock and in forcing the animals to their utmost development.

For showing purposes the lambs must be early, and lambing should commence at the beginning of the year. February is a favourite month. The ewes and lambs are given every chance of thriving. Mangels and trough feeding go hand-in-hand. Early spring cabbage, kale, and rye produce a liberal flow of milk. The lambs are weaned in June and penned, receiving food on the soiling system. Green vetches are given at first, and these are followed by early aftermath clover. Cabbages of the early Enfield variety are ready in July and August. White turnips, kohlrabi, and thousand-headed kale follow. After Christmas the young sheep are put on swedes. Clipping is done early, as a good fleece is desirable in July at the sheep sales. Shearlings are put on seeds and given trough food with cut mangels, cabbages and tares, and are given shelter from the sun or rain.

PRICES OBTAINED.—At Mr. Henry Dudding's annual sale in 1906 the record price of 1450 gs. was obtained for a shearling ram, which went to the Argentine. At Messrs. Dean & Sons' annual sale at Lincoln in July, 1908, forty-eight rams were sold at the average price of £29, 18*s.* 3*d.* each. In the previous year (1907) the average price obtained was £37, 5*s.* 6*d.*, and there was even a higher average in 1906, which was the record year for prices. The great rise in the value of wool, which became marked in 1904 and reached its highest point in 1906, has had a great deal to do with the higher prices obtained, and the increased export demand for these excellent wool-producing sheep, which was also at its maximum in 1906.

[D. A. G.] [F. W.]

Lincolnshire Buff Fowl.—This breed is kept in eastern England, where it has been known for a considerable period. Apparently its origin was due to the crossing of the Buff Cochin with the common fowl of the country, and afterwards with the Dorking. It is a rather large-sized race, with buff-coloured plumage, legs which are very white, and white skin and flesh. It is a hardy fowl, not a very rapid grower, but excellent in flesh qualities, and is a fair winter layer. It is unnecessary to deal with the breed at length, because all the evidence shows that it is closely related to the Buff Orpington, in fact many of the present-day Buff Orpingtons are simply refined Lincolnshire Buffs. The reader is therefore referred to the article relating to that breed for further particulars. [E. B.]

Lincolnshire Curly-coated Pigs have to the writer's knowledge been bred for at least half a century on much the same lines as at present, within that county after which this breed of pigs is named. It has just those qualities which render it especially suitable for consumption in the farmhouse or ground keeper's or farm steward's house, in which the hired hands — be they shepherds, horse keepers, or others—are boarded by the farmer or his foreman. They are hardy, prolific, and grow to an immense size if kept to

any great age, as it is the fashion so to do. Fifty years ago, the store pigs were kept at comparatively little expense for food other than that grown on the farm until they reached the age of twelve to fifteen months, when they would be put up to fatten for some months, after which they would furnish a carcass of some 600 lb.; not perhaps of the finest quality of meat, or such as would be suitable for the trade in a fashionable part of London, but pork which, eaten fresh, or as heavily salted bacon, would be of a very satisfying character. The old system of reserving each season a number of young sows, which would be allowed to produce one litter in the early summer and then in the autumn be converted into pork, is not now so generally followed. Hence the beneficial results which have accrued from the selection of good sires and from the practice of breeding from those sows which have proved themselves to be prolific and good sucklers, are much in evidence. The quality of the skin, bone, and flesh of these improved pigs has certainly improved, but further attention may be still profitably paid to these points, as well as to length of body and lightness of offal. This fact will force itself on the attention of the breeders of the Lincolnshire Curly-coated pig as it comes more into contact with pigs of some other breeds, when exhibited at the few shows at which separate classes for the Lincolns are provided. It is true that classes have for some years been provided for these local pigs at the Lincolnshire County shows, but for some reason or other the exhibits of white pigs of the other recognized breeds have not of late been large or fully representative. There has also been considerable diversity of type and character amongst the Curly-coated pigs exhibited. This should in the future become much less general, if it does not wholly cease, since the breed has now a herd-book society with a very energetic executive, who will doubtless give their special attention to the improvement of their favourites in those special points on which pig-breeders in other parts of the world are compelled by public taste or fancy to give particular notice. The admirers of this county breed have the best of foundations to work upon, as the Curly-coated pigs are hardy, thrifty, quick growers, and the sows of the breed are both prolific and good milkers. [S. S.]

Lincolnshire Red Shorthorns.—Before the year 1895 the Lincoln Reds, as the Lincolnshire Red Shorthorns are popularly called, were little known beyond their native boundaries, although Lincolnshire had long ago earned the proud title of premier agricultural county in England. It was in that year that the Lincolnshire Red Shorthorn Association was formed to promote the interests of this variety of the great Shorthorn race, by publishing a register, and securing uniformity of type and colour. There were (in 1909) 320 members of the association, and 741 bulls and 663 cows and heifers were entered in the 15th vol. of the Herd Book, the number of bulls entered now being 6526. But it was not till the year 1901, when the Royal Agricultural Society of England first granted them special breed classes at their exhibition at Cardiff, that the cattle really began to attract attention, and the comments of the ring side, both from foreign buyers and home breeders, were distinctly favourable; the general opinion was that they were bred on Shorthorn lines to a well-defined type and colour, showed great wealth and evenness of flesh, and were possessed of undeniable milking qualities. Since then there has been a steady advance both in the appearance and the popularity of the cattle. There has been no 'booming', no sensational prices, and no flourish of trumpets; but the cattle have been making their worth known by the best of all possible tests—practical experience. For many years their admirers had claimed the Lincoln Reds to be the ideal tenant farmer's cattle, hardy and thrifty, and with the soundest of constitutions; that they were economical feeders, and animals that came quickly to maturity; a race of beef and milk producers; and, in fact, real rent-payers. But of late years the lessons of the show ring have resulted in greater Shorthorn neatness, better backs, and shorter legs; and this without losing the qualities that make them so valuable, not only to the men of Lincolnshire, but to a rapidly increasing number of tenant farmers in all parts of England, in the dairy countries of Europe, and in South America, Australasia, and South Africa.

The original cattle of Great Britain, which the Romans found on their invasion of the country, were the *Bos longifrons*; and Julius Cæsar left it on record that 'the number of its cattle was great'. These were later on crossed with a modified type of the *Bos urus* which was imported by the inhabitants of Jutland, Holstein, and Friesland when they invaded the country between 449 and 660 A.D.; and it must be remembered that these people came both as fighting men, with fresh conquests to make, and also as colonists, bringing with them their wives and children, their cattle and *lares et penates* generally. To these people must be attributed our improved system of farming and the larger type of cattle from which all our more valuable breeds are descended, and their influence was most felt in the counties of Yorkshire and Lincolnshire. Gervaise Markham, in his book A Way to Get Wealth, published in 1695, spoke of the Lincolnshire cattle as being for the most part 'pyde, with more white than the other colours; their horns little and crooked, of bodies exceeding tall, long and large, lean and thin-thighed, strong hoved, not apt to sorbate, and are indeed fitted to labour and draught'. But the gradual importation of Dutch cattle and an improved system of breeding had its effect; and George Culley, in Observations on Live Stock, published in 1785, says that there is little doubt that 'the shorthorned or Dutch kind' was imported from the Continent, first because they are in many places still called the Dutch breed, and secondly because very few of them were to be found except along the eastern coast of the island, facing that part of the Continent where the cattle were still bred. 'In Lincolnshire,' says Culley, 'which is the furthest south that one meets with any number of this

breed of cattle, they are, in general, more subject to lyer or black flesh than those bred further north; and in that part of Yorkshire called Holderness they are much the same as those of which we have been speaking.' In a later edition of his book, published in 1792, Culley remarks that in a journey through Lincolnshire in 1784 he was happy to find that many sensible breeders had improved their breed of Shorthorn cattle very much, since his tour in that country two years previously, by using good bulls and heifers brought from the counties of York and Durham on both sides of the Tees, where the best were confessedly bred. It must be remembered that the Dutch did not create the Shorthorn breed, but they helped to improve it by introducing greater milking qualities. The importation of Dutch cattle for crossing with the Shorthorn had wholly ceased before the time of the Collings; and it is with the introduction of the Ketton and Barmton blood into the county about the middle of the last quarter of the 18th century that the real improvement of Lincolnshire cattle must date. The original cattle of Lincolnshire in their unimproved state were distinguished by their enormous size, but slow powers of fattening; and, besides the introduction of the Colling blood, one of the most potent factors in bringing Lincolnshire Shorthorns to their present type was the herd formed by Mr. Thomas Turnell at Reasby, near Wragby, towards the close of the 18th century. Mr. Arthur Young, in his report to the Board of Agriculture, says: 'Mr. Turnell has a breed of cattle which are not surpassed by any in the county for points highly valuable, or their disposition at any age to fatten rapidly. His bull covers at a guinea, and has many cows sent to him. The breed originally came from the neighbourhood of Darlington.' Mr. Turnell impressed his cattle with the deep cherry-red colour now so much the fashion, and while slightly reducing their size from the original type, gave them greater powers of rapid fattening, and of developing the primest joints of meat. Mr. Charles Colling's bulls at Ketton used to be let out by the year at 50 gs. and 100 gs. each, and among his hirers was Mr. Ostler of Aylesby, in Lincolnshire. It was at the Ketton sale on October 11, 1810, that the first great introduction of Colling blood into the county took place, and it was of the choicest. For instance, Mr. Grant of Wyham gave 210 gs. for the cow Laura, who was by Favourite (252), whose dam was Lady Maynard, originally called Favourite, who was bought of Mr. Maynard of Eryholme, and practically laid the foundation of the modern Shorthorn. Laura was out of a very good cow called Lady; and Mr. Grant also gave 106 gs. for Lady's bull calf, Lucilla, by Comet (155), and 200 gs. for the bull Major (397). Mr. Grant used to cross his Turnell cattle with Colling-bred bulls. Both Favourite and Comet were famous bulls; and of the latter, who was a son of Favourite, Mr. George Coates said, 'I never saw his equal', while Mr. Charles Colling declared him to be the best bull he ever bred or saw. Mr. Philip Skipworth of Aylesby also paid 140 gs. for Young Favourite (254), by Comet, at this sale; and he made numerous purchases at Mr. Robert Colling's sale at Barmton on September 29 and 30, 1818, as did Mr. J. White, Coates, Mr. Leighton, North Willingham, and Mr. W. Brooks, Laceby. More cattle went into Lincolnshire from Mr. Christopher Mason's sale at Chilton, Durham, on Aug. 31 and Sept. 1, 1829, Mr. Dudding taking the bull Childers to Panton at 225 gs.; and yet again, from the sale of Mr. Thomas Bates's herd at Kirklevington on May 9, 1850, Mr. Cartwright, Haugham, Louth, and Mr. H. Campion, Ranby, buying several of the Wild Eyes and Duchesses. The fame of Mr. W. Torr's herd at Aylesby, in North Lincolnshire, was world-wide, and his sale on Sept. 2, 1875, when 84 head, all bred by their late owner, averaged £510, 19*s*., stands as a landmark in Shorthorn history Mr. W. Smith, West Rasen, from whose herd sprung the Mazurka family, thought so highly of in America, was another noted Lincolnshire breeder; while others who followed in the footsteps of Mr. Turnell were Mr. Coulam of Withern, Mr. Baumber of Somersby, Mr. Oliver of Eresby, and Mr. Cartwright of Tathwell; and Mr. Redmile, of Dyke, and Lord Willoughby de Eresby introduced cattle from the herd of Mr. Oliver of Eresby into the extreme south of the county. It will thus be seen on what a sure foundation the Lincoln Red breed of cattle has been built up. But for some reason or other the bulk of the breeders in the county refrained from registering their cattle in Coates's Herd Book; and gradually conforming to one type and colour by using none but red bulls from herds of renowned constitution within the limits of the county, and by only dipping into C.H.B. blood by introducing red bulls for an out-cross, they eventually developed a distinct breed of Red Shorthorns, which was claimed to possess more hardiness and thriftiness, greater ability to come to early maturity and to fatten quicker, and with better milking qualities than the parent breed. And now 98 per cent of the cattle bred in the county are Red Shorthorns, either unregistered, or registered in the Lincolnshire Red Shorthorn Society's Herd Book.

It is claimed by the admirers of the breed that the cattle are the ideal tenant farmer's cattle, and their history shows that the boast is no idle one. Wintered in fold yards, with little or no shelter; fed on barley straw and a few turnips; exposed to the coldest of winds and the wettest of weather, the weakest have been weeded out with most marvellous certainty. About the middle of April they are turned out to get their own living, facing the biting east winds from the North Sea; and if there is any delicacy in cow or calf it is soon discovered. During the hot months of summer there is often little drink but such as is provided by stagnant ponds. This is the test that has been going on in the case of the Lincoln Reds for a hundred years and more. And the result? Distinctly a case of the survival of the fittest; a race of cattle that not only do not lose their condition under circumstances that would have had the most disastrous results as regards most breeds, but thrive and grow on and im-

prove, laying on a wealth of lean flesh and providing a bountiful supply of rich milk for the nourishing of their offspring. This is a state of things that tenant farmers all over England and in the Colonies should take notice of, this ability to grow and develop where most breeds would pine and shrink, and to bring up two or more calves besides their own. At two and a half years old the grass-fed steers may be looked upon to yield from 8 to 10 cwt. of the best meat, and stall fed cattle up to 24 cwt.; and the butchers say they cut up a far greater proportion of lean flesh, with very much less offal, than any other breed they know. By judicious selection and proper treatment the great milking capabilities of the breed may easily be developed, as has been proved by Mr. John Evens's wonderful successes in the chief milking trials in England and Ireland, where he has demonstrated the superiority of the Lincoln Reds over all other breeds. The reputation of the breed as an ideal dual-purpose cattle is thus fully established; for no other breed can boast such beef-producing steers, and at the same time such milk-producing females.

It has been previously mentioned that practically the whole of the cattle of Lincolnshire are Lincoln Reds, and there are also registered herds in Huntingdonshire, Nottinghamshire, Leicestershire, Northamptonshire, Warwickshire, Cheshire, Norfolk, Suffolk, Yorkshire, Kent, Surrey, Cambridgeshire, Rutlandshire, Hertfordshire, and County Down, Ireland. The leading dairy countries of Europe have long been purchasers of bulls and heifers, and the cattle are being exported to South Africa and Brazil in rapidly increasing numbers each year. Indeed one Government agent, who had been touring all over the United Kingdom purchasing cattle, pronounced the Lincoln Reds to be more suited to the requirements for South Africa than any other breed. In 1907 a Lincoln Red bull, bred by Col. C. A. Swan at Sausthorpe Hall, and used by Mr. G. E. Sandars in his herd at Scampton, near Lincoln, was sold by the latter gentleman to the Government of the Orange River Colony, and at the Bloemfontein Show it won the championship against all-comers. At the New South Wales Show in 1908 Mr. H. M. D. Livingstone of Mullumbimby showed his Lincoln Red bull, Burton New Cross (4725), with the following results: first prize for bull shown with three of his progeny, first for best bull to get stock for dairy purposes, champion Durham bull, and grand championship for the best bull of any breed on the show ground. This bull, who was bred by Mr. J. Evens, Burton, Lincoln, was calved in Sept. 1905, being by the 'Royal' winner Scampton Expansion (4093) from Burton Cross II, a London Dairy Show winner. Argentina has hitherto bought somewhat sparsely, the absence of a lengthy C.H.B. pedigree acting to the disadvantage of the cattle; but they are gradually but surely making their true worth known, and the trade is increasing each year. The introduction of the blood into Ireland has proved most beneficial, particularly in dairy districts, and a number of purchases are made each year by the Congested Districts Board at the annual bull sale of the Lincolnshire Red Shorthorn Association, held in April at Lincoln. Both the Duke of Devonshire and the Duke of Portland purchase bulls for the use of their tenants. The annual bull sales at Lincoln were conducted under the auspices of the Lincolnshire Red Shorthorn Association at its formation in 1895, and have proved most successful, no fewer than 2630 bulls having been disposed of at the fourteen sales for a total sum of £66,470, 18*s.* and an average of £25, 5*s.* 8*d.* The best average was obtained in 1909, when 238 bulls were sold at an average of £28, 6*s.* 6*d.*, the highest price being 165 gs., which Mr. F. B. Wilkinson, Edwinstowe, Newark, paid for Dunsby Red 3rd, the property of Mr. J. W. Measures, Dunsby, Bourne. But the record price was obtained for Mr. G. E. Sandars's Scampton Goldreef, who was sold to Mr. Cockbain, to go to Chile, at 305 gs. in 1906. Annual bull sales are also held at Boston each May, and at Alford each November. The Alford sales are particularly successful, and at the 1906 sale, Brandon Grenadier (4274), the 'Royal' winner, and the property of Mr. J. Langham, Brandon Grange, was sold to Mr. G. E. Sandars, Scampton, at 200 gs. A few private auction sales are held each year, the best in 1900 being that of Mr. C. H. Stafford, Fledborough, Newark, where 41 head averaged £33, 5*s.* 10*d.* In 1901 Messrs. R. and R. Chatterton, Stenigot, disposed of 89 head at an average of £35, 10*s.* 10*d.*, the highest price being 110 gs., which Mr. T. Bett, Benniworth, paid for Red Chief (2611). Mr. W. J. Atkinson, Weston, Spalding, had a sale in 1904, when his average was £27, 4*s.* for 65, and the bull Weston Monarch II went to Mr. S. Crawley, Hemington, at 120 gs.; and in the same year Mr. G. Freir, Deeping St. Nicholas, disposed of 70 at an average of £23, 9*s.* 11*d.* The best sale in 1905 was that held by Messrs. S. E. Dean & Sons, of Dowsby Hall, Bourne, whose average for 81 was £27, 11*s.* 5*d.* The feature of the 1906 private sales was that held at Keddington, near Louth, when a choice selection from Mr. E. H. Cartwright's well-known herd was disposed of at an average of £40, 9*s.*, the highest price being 104 gs., which Mr. G. Marris, Kirmington House, Brocklesby, paid for the two-year-old heifer Keddington Favourite 4th, by Vanguard (2691). The late Mr. T. B. Freshney's small but well-bred herd was also dispersed this year, the average for 56 being £21, 0*s.* 8*d.*, and Ruby 12th, by Benniworth 4th (629), went at 106 gs. to Mr. E. Bourne, Louth. The late Mr. T. Bett's herd was likewise dispersed this year, the average for 57 head being £25, 9*s.* 2*d.* A great number of private sales were held in 1907, the averages for the chief being as follows: Mr. G. Freir, 48 at £26, 19*s.*; Mr. W. A. Ewbank, Covenham, Louth (dispersal), 72 at £23, 14*s.* 8*d.*; Mr. J. Crawley, Church Lawford, Rugby, 42 at £23, 11*s.* 9*d.*; the late Mr. G. Laughton, Belchford, Horncastle (dispersal), 38 at £23, 4*s.* 2*d.*; Messrs. J. W. Farrow & Sons, Strubby Manor, Alford, 71 at £30, 13*s.* 7*d.*; Mr. W. J. Atkinson, 63 at £34, 2*s.* 8*d.*; Mr. J. Langham, Brandon Grange, 65 at £23, 3*s.* 7*d.*; and Mr. Robert Chatterton,

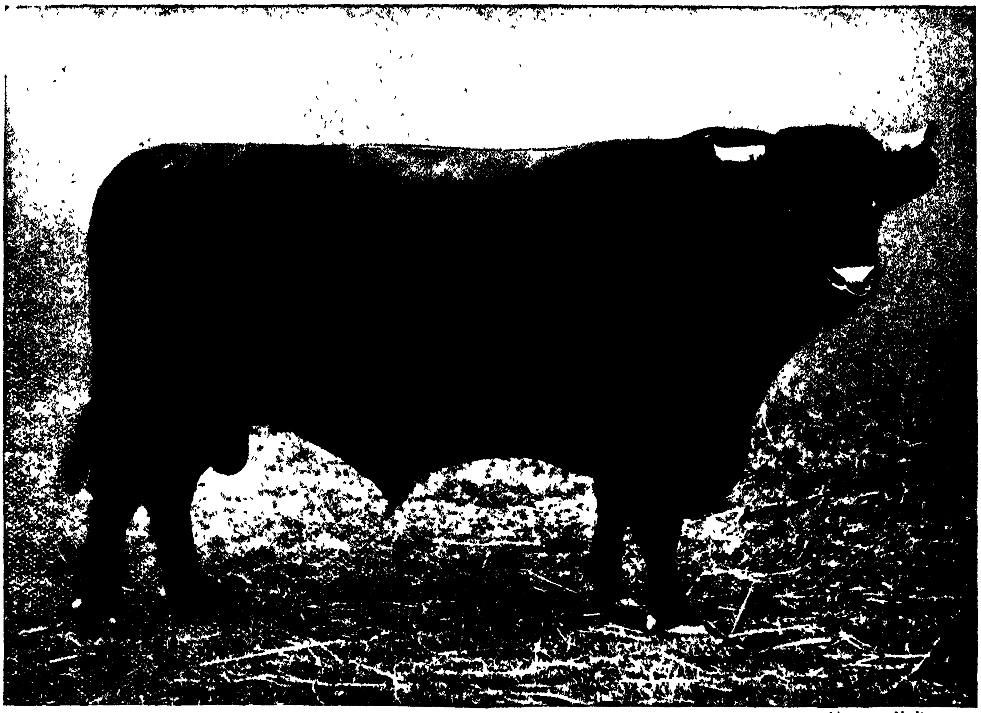


Photo G. H. Parsons

LINCOLNSHIRE RED SHORTHORN BULL—"SCAMPTON EXILE"

WINNER OF FIRST PRIZE AT THE R.A.S.E. AND LINCOLNSHIRE SHOWS, 1909

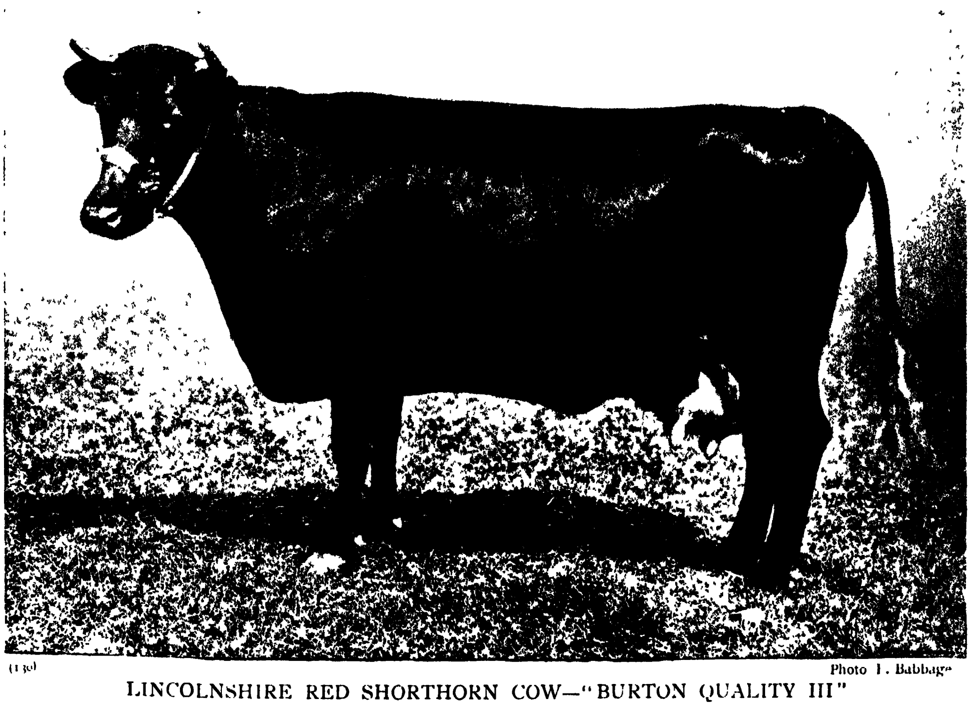


Photo T. Babbage

LINCOLNSHIRE RED SHORTHORN COW—"BURTON QUALITY III"

WINNER OF [illegible]

Stenigot, 66 at £43, 10*s.* 4*d.* At this latter sale the bull Stenigot Duchess Beau, a 'Royal' winner, was sold to Mr. D. Frame, to go to South Africa, at 99 gs. The best private sale in 1908 was at The Crown Farm Croft, when a selection of 60 head from Mr. John Searby's herd averaged £27, 7*s.*

Reference has been made to the pioneers of Red Shorthorn breeding in Lincolnshire, but none have done more to maintain the character of the cattle and to bring them to a greater state of perfection than the Messrs. Chatterton of Stenigot and Hallington, which herds are now the respective property of Mr. Robert and Mr. William Chatterton. The foundation of these herds may be said to have been laid with the purchase, by the late Mr. W. Chatterton of Hallington, of a famous cow from Mr. Coulam of Withern. She dropped a red heifer calf called Alcama, which was sent in 1872 to the Marquis of Exeter's celebrated bull, Cambridge Duke 5th (C.H.B. 30,644), who combined the Duchess and Red Rose blood. The result of this union was the bull Hercules (144), who was used in the Hallington herd for nine seasons, and proved a most famous sire. Both the Stenigot and Hallington blood is in high repute, and while both owners have sold many high-class bulls and heifers to go to Argentina and elsewhere, the former herd has been exceptionally successful at the Royal, Lincolnshire, and other shows.

Mr. E. H. Cartwright's herd at Keddington is quite in the foremost rank, and has done much to make Lincoln Red history. A bull that did a vast amount of good in the herd was Windsor Benedict (C.H.B. 40,933); while such noted sires as Bigby (319), Benniworth 4th (629), and Conisholme Boy (347) left their mark in the herd. Mr. Cartwright also bred the famous Keddington Ruby (1243), who proved such an impressive sire in Mr. G. E. Sandars's herd at Scampton.

The late Mr. T. B. Freshney of South Somercotes had a herd of considerable repute, and his Ruby family was one of the most famous in the county. His bull Saltfleet Bonus (3582), a massive heavy-fleshed son of Red Monarch (C.H.B. 77,605) and a cow by Lord Knightley (170), was awarded the championship of the Lincolnshire Show in 1905, beating Mr. Philo Mills's famous bull King Christian of Denmark, who won many championships all over the country, and was sold at the Ruddington dispersal sale for 900 gs.

Mr. John Evens's now world-famous dairy herd at Burton, near Lincoln, has descended from father to son for generations, and he himself took it over in 1875. It is Mr. Evens who has demonstrated to the world, by means of his wonderful successes in milking trials and butter tests in England and Ireland, the great dairy properties of the Lincoln Reds. Mr. F. Scorer, Bracebridge, Lincoln, and Miss K. Carleton, Gilford Castle, Co. Down, are following in his footsteps, and others are also beginning to turn the great milking qualities of the breed to account. Mr. Evens commenced showing in 1887, when he carried off the Lord Mayor's champion cup at the London Milking Trials with Beauty, a cow that gave 3673 gal. of milk in thirty-four months; and ever since then his showyard record has been one continual series of successes. He has won the first prize and challenge cup at the Belfast Milking Trials in three consecutive years, and at the Royal Dublin Milking Trials the first prize and challenge cup in four consecutive years. At Tring the Burton herd have carried off four first, two second, one third, and two fourth prizes in seven years, and these are the largest and most representative milking trials in England. One year his winning cow gave 75 lb. of milk in twenty-four hours, and twice his cows have exceeded 71 lb. Besides this, he has repeatedly won at the Oxfordshire, Royal Counties, Royal Show, Somersetshire, Bath and West, and London Dairy Show Milking Trials and Butter Tests, as well as at all the leading shows in inspection classes. In 1907, besides victories at Newark, the Oxfordshire, Peterborough, Eastern Counties, Derbyshire, Tring, London, Lord Tredegar's and other local shows, Mr. Evens carried off five first prizes, six seconds, three thirds, and two fourth prizes at the Royal Show at Lincoln, where the breeders of the Lincoln Reds made special efforts to make the exhibition of their cattle a worthy one. Mr. Evens also carried off the premier and third honours in the Open Milk Test, in which the average of the breed came out ahead of all others. That year Mr. Evens took first and second prizes at the Tring Milking Trials, and in 1908 he was third, one tablespoonful of milk dividing the first three cows. In 1908, the Burton cattle captured a first and second at Newark; first and second both in the Open and Tenant Farmers' class for the SIXTH year in succession at the Oxfordshire Milking Trials; first at the Bath and West Milking Trials; second at the Royal Counties Milking Trials; second at the Nottinghamshire; a first, second, third, and fourth at Peterborough; two firsts, a second, and two thirds at the Lincolnshire; a first and two thirds at the Royal Show at Newcastle; and at the dairy tests there, a first and second in the Lincoln Red Milk Test, second and fifth in the Open Milk Test, second special for the most butter in the show, and second, fifth, and sixth in the Open Butter Test. At the London Dairy Show in 1908 he took two first prizes, three seconds, and four thirds. His handsome cow, Burton Quality 3rd, beat the 1904, 1905, and 1906 Lincoln Red female champions at the Royal Show at Lincoln, and was awarded the championship of the Lincolnshire show at Sleaford in 1908; and his numerous victories have proved that a Lincoln Red herd can produce both beef and milk. The morning and evening milk of each cow at Burton has been weighed and recorded since March 23, 1885, and the forty-eight cows calving in 1906 yielded 385,261 lb. milk, an average per cow (including seventeen first-calf heifers) of 802 gal. There are now twenty-six cows in the Burton herd that have won in public show yards and milking trials.

Probably no herd has produced such successful sires in recent years as has the Scampton

herd belonging to Mr. G. E. Sandars, much of the success of this herd being due to Keddington Ruby (1243), whose sons have made more money at the association's sales at Lincoln than have those of any other breeder. On ten occasions in twenty years Mr. Sandars has secured the highest individual price, and on thirteen occasions he has had the highest average. To him belongs the honour of the record price for a Lincoln Red, that of 305 gs., which was paid by Mr. Cockbain for Scampton Goldreef (4569), a bull destined for Chile; and he himself paid 200 gs. at Alford in 1906 for Mr. J. Langham's Brandon Grenadier (4274), a 'Royal' winner, who in his new owner's hands won first prize and reserve for the championship at the Royal Show at Lincoln in 1907. His conqueror on this occasion, and who afterwards carried off the championship honours at the Lincolnshire show at Sleaford in 1908, beating all the 'Royal' winners, was Mr. B. Rowland's Scampton Exile (4092), a bull of Mr. Sandars's own breeding. Scampton Exile is a very massive, heavy-fleshed bull by Keddington Ruby (1243), his dam being by King Hal (136), his grandam by Hallington (135), and his great-grandam by Cawkwell (67); and he was reserved for the championship of the show to the champion bull in Great Britain, Sir R. P. Cooper's roan, Chiddingstone Malcolm. Other prominent breeders are Messrs. T. W. Dickinson, Worlaby, whose bulls are always in great demand at the Lincoln sales; Messrs. S. E. Dean & Sons, Dowsby Hall, who paid 700 gs. for the bull calf Imperial Favourite (C.H.B. 86,233) (to whom a great number of Lincoln Red breeders sent cows) at Mr. W. S. Marr's sale at Uppermill, Aberdeenshire, and afterwards sold him in Buenos Ayres for the equivalent of 1000 gs.; Mr. Reuben Roberts, Horncastle, who has a very old and very noted herd; Mr. G. Marris, Kirmington House, Brocklesby, who, among other purchases at Mr. E. H. Cartwright's sale at Keddington in 1906, bought the beautiful heifer, Keddington Favourite 4th, for 104 gs., with which he won at the 'Royal' both in 1907 and 1908; Mr. W. B. Swallow, Wootton and Horkstow, who spares no expense in obtaining the best sires, giving, for instance, 105 gs. for Messrs. S. & J. W. T. Crawley's Bumper II (1703) at the Lincoln sales in 1900, and 140 gs. for Mr. G. E. Sandars's Scampton Hermes (4972) at the sales in 1907; Mr. W. J. Atkinson, Weston St. Mary, and Mr. G. Freir, Deeping St. Nicholas, both of whom have always found a ready demand for their well-bred animals. Mr. F. Scorer, Bracebridge, and Miss K. Carleton, Gilford Castle, Co. Down, have herds that are fast coming to the front in dairy tests; and Mr. Scorer's cow Bracebridge (No. 102), which won in the milk test at the London Dairy Show in 1908 gave no less than 1703 gal. of milk in fifty-four weeks. Other good herds are owned by Mr. S. Crawley, Hemington, Oundle; Mr. J. Crawley, Church Lawford, Rugby; Mr. J. Searby, Croft; Mr. J. G. Williams, Pendley Manor, Tring (most successful in the show ring); Captain E. M. Grantham, West Keal; Lord Heneage, Hainton Hall; Messrs. C. Hensman & Son, Fulletty Grange; Mr. J. Langham, Brandon Grange (another very successful exhibitor); Mr. J. Mason, Calceby Manor; Mr. J. W. Measures, Dunsby; Mr. J. C. Mountain, Welbourne; Captain the Hon. G. B. Portman, Healing Manor; and Lord Percy, Guy's Cliffe, Warwick. [G. E. C.]

Lindley, John, LL.D., one of the most distinguished of English botanists, and author of a great number of works on botany and kindred subjects. Dr. Lindley was born in 1799 at Catton, near Norwich, where his father was a nurseryman, which accounts for the bent of the young man's mind towards horticultural and botanical topics. He must have been a zealous student early in life, for he published a translation of Richard's Analyse du Fruit when he was only twenty years old, and in the course of the next three years his Monographia Rosarum, Observations on Pomaceæ (in the Transactions of the Linnæan Society), a paper on the Lemnas, Monographia Digitalium, and Collectanea Botanica. Shortly afterwards he began one of the great works of his life by writing the most important portions of Loudon's Encyclopædia of Plants. Others of his works are: Introduction to the Natural System in Botany, Introduction to Systematic and Physiological Botany, Synopsis of the British Flora, Key to Systematic Botany, Outlines of the First Principles of Botany, A Natural System of Botany (afterwards amplified and entitled The Vegetable Kingdom), Flora Medica, Theory of Horticulture, Ladies' Botany, and School Botany. When the Penny Cyclopædia was started, Lindley was employed to write the botanical articles, and continued to write them as far as the letter R. Lindley also contributed the great botanical articles to Morton's Cyclopedia of Agriculture, and these revised and brought up to date appear in the present work. Voluminous though his work as an author of books and papers for scientific periodicals was, it did not exhaust Lindley's wonderful energy. In 1829 he became professor of botany at London University (now University College, London), in 1831 lecturer on botany at the Royal Institution, and in 1835 lecturer on botany at the Botanic Gardens, Chelsea. A still earlier appointment, in 1822, was that of garden assistant secretary to the Horticultural Society before it was entitled to prefix the word 'Royal' to its name. His position was successively raised to that of sole assistant secretary in 1826, vice-secretary in 1841, and secretary in 1858. This last position he held until 1862. At the beginning of 1841 the Gardener's Chronicle was started as a weekly paper, and Dr. Lindley became its first editor, a post which he retained until his death in November, 1865. Among the honours which he received was the degree of Ph.D., conferred upon him by the University of Munich. He was a Fellow of the Linnæan and Geological societies, president of the Microscopical Society, and corresponding member of several foreign scientific bodies. [W. E. B.]

Liniment.—Liniments are liquid preparations for external application with more or less friction or massage, and the term is synonymous with that of embrocation. With a basis of soap, oil, or spirit of wine, they act as vehicles for

more potent drugs, and in a form most conveniently applied. Active principles, not soluble in water, may often be utilized when dissolved by turpentine or other volatile or fixed oils. The saponaceous liniments afford us means of combining water and oil, as when liquid ammonia and olive oil and spirit of turpentine are combined to make the emulsion known as white oils. It should be always borne in mind that the thick and hairy skins of animals are more susceptible to these applications than those of man, and that they are more readily blistered. [H. L.]

Linnet (*Linota cannabina*).—This familiar little native finch is common except in North Scotland, frequenting waste lands and commons. The plumage is a sober brown, but the male has a reddish poll and white edges to his tail. The neat nest is made of twigs and moss, with a lining of wool and hair. It is occasionally built in a tree, but more usually in a bush, very commonly a furze bush, not far from the ground. The four to six eggs are dirty-white in colour, with a band of brown spots at the large end. The food consists of seeds, mostly those of weeds, such as charlock, dock, hawkweed, and dandelion. Speaking of a large flock of several hundred birds observed in North Wales, Mr. Robert Newstead says: 'Feeding together on the seeds of the charlock, which had practically overgrown a field of potatoes. I did not observe any other birds with them. The trees adjacent to the field in question were alive with them.' And again, of a small flock (in company with chaffinches, greenfinches, and yellow buntings), also in North Wales: 'Feeding on the seeds of the charlock in a wheat stubble. The dead charlock plants were in proportion to the corn plants about 50 per cent. Almost all the seeds had been extracted, and the ground was strewn with open pods and other fragments of the seed vessels' (Supplement to Journal of Board of Agriculture, xv, No. 9, December, 1908, p. 44). Linnets destroy a small amount of crop-seeds, but their influence is so predominatingly beneficial that they merit the most rigid protection. [J. R. A. D.]

Linseed.—Linseed is the seed of the flax plant, *Linum usitatissimum*, L., which belongs to the nat. ord. Linaceæ. The seed is albuminous, and flattened in shape. It belongs to the class of seeds known generally as 'oilseeds', and is mainly valuable for the oil (linseed oil) which it yields. The flax plant is but little cultivated in the United Kingdom, and practically never for the sake of the seed; in the north of Ireland the plant is grown to a considerable extent for the sake of its fibre—flax. The great linseed-producing countries are North and South America, Russia, and India. Morocco and Turkey also supply smaller amounts. The principal uses of linseed are: (1) the oil—for paint, varnish, soap, and linoleum making, while a certain quantity is also used for medicinal purposes; (2) the residue of the seed, after extraction of the oil—for the manufacture of a feeding material, linseed cake. The following table gives the exports of linseed in 1907 and 1908 from the different countries in which it is produced, together with the net imports into the United Kingdom:—

	Exports, 1907.	Exports, 1908.
	tons.	tons.
Calcutta	216,357	110,188
Bombay	118,857	52,642
Argentine (La Plata)	831,887	1,082,264
Russian and Black Sea	78,553	118,186
North America	122,657	42,400
Total	1,368,311	1,405,680
United Kingdom—net Imports	312,537	382,169

The seed, inasmuch as it comes from different countries, varies considerably in quality, and commands different prices according mainly to its yield of oil and the particular purposes for which that oil is best adapted. It may be said generally that Indian seed always commands the highest price because of the high oil yield. Season also will frequently cause considerable variations in the amount of oil the seed will contain, and with some classes of seed this may fluctuate materially from year to year. In this respect Indian seed varies least, Bombay linseed containing, fairly regularly, about 42 per cent of oil, and Calcutta seed 39 per cent. Argentine (La Plata) seed and Baltic seed, on the other hand, vary markedly according to season.

In North America linseed is produced generally throughout the States, and is usually known as 'Duluth', while Canada gives linseed that goes by the name 'Manitoba.' In South America, La Plata seed is the most common; this is grown in the Argentine, while 'Chilian' linseed comes mainly from Bolivia. This class of seed produces generally the lowest grades of oil, but it is much liked for linseed-cake manufacture, producing a soft cake rich in albuminoids. The oil percentage in the seed ranges from 35 to 38 per cent. Russia supplies seed variously known under the names Baltic (including Petersburg, Riga, and Königsberg), Archangel, and Black Sea. Baltic seed generally gives the best oil for paint, varnish, linoleum, &c., but Black Sea linseed often contains a lot of rape, which is grown with it; it gives a high oil yield, but produces a hard cake. Riga seed also is very liable to be much mixed with weed seeds and to be dirty. Morocco and Turkey produce a seed that varies much in quality according to the season, but it is very clean, and finds favour chiefly for use as feeding linseed, when linseed is used direct without previous expression of the oil.

The prices of linseed are subject to considerable fluctuation, due partly to the production in different countries, and partly to the variations of season. Accordingly, the prices of both oil and cake are subject to great changes; the price of linseed cake being regulated mainly by the amount of oil left in it after manufacture.

The seed is first passed through screens of various patterns to remove weed and foreign seeds, dirt, &c., and is then put through chilled

iron rollers, in which it is crushed. In earlier times the seed was crushed in stone mills, but few of these now remain. The crushed seed is transferred to a 'kettle', where it is heated up with steam (this rendering the oil more ready of extraction), after which it is packed in long bags which are laid within metal moulds, and these are placed in hydraulic presses. The oil gradually oozes out when the pressure is applied, and is collected; while, after the pressure is taken off and the moulds removed, the bags are stripped off and the cake is left, ready for use. According to the pressure applied and the length of time this is continued, as also having regard to the quality of the seed, so is it possible, with care, to regulate the quantity of oil left in the cake. There has been a great advance in more recent times in the matter of the presses used, and these are now almost universally of the Anglo-American type, which can reduce the oil in linseed cake to as little as 6 per cent. In earlier times, and mainly in country mills, less perfect presses were employed, and in these it was not possible to reduce the oil in linseed cake below 10 or 11 per cent. These presses have now practically been replaced everywhere by the newer type.

At one time—about twenty years ago—it was sometimes the practice in America to extract the oil from linseed by chemical means, using benzol or similar solvents and selling the extracted meal, practically deprived altogether of oil, as 'Cleveland meal'. This practice has, however, now quite gone out of use so far as linseed is concerned, though it is extensively employed as regards other oilseeds.

The great centre of the oilseed trade is Hull, this port handling about one-half of all the oilseeds coming into this country. Of late, however, there has been a considerable extension of mills throughout the country, and important fresh crushing centres, fitted with the most recent machinery, have sprung up, so that Hull has no longer the monopoly it once enjoyed.

On the farm, linseed is to a certain extent used in its uncrushed state, as 'feeding linseed'. As already stated, the seed so used is that mainly coming from Morocco and Turkey, this seed being very clean. Linseed so employed is either given whole, or is lightly crushed on the farm, or is made up into 'linseed jelly', the seed being crushed and mixed with warm water, when it swells up and forms a kind of jelly. This is due mainly to the mucilage which the seed contains. When fed whole and uncrushed, linseed is principally used for animals that are being 'finished off', and to impart a 'gloss' to them, the oil no doubt contributing largely to this. Though it may 'pay' to do this under such special circumstances, the regular feeding with linseed cannot be considered economical, as there is great tendency for the seed to pass through the animal unused, and it requires, moreover, to be used with care, or else it may produce 'scouring', linseed having a decidedly laxative effect. For quite young animals, or for sick animals, the use of 'linseed jelly' may, however, be very advantageous. In compound feeding cakes linseed is also sometimes used, and largely with the object of raising the oil percentage. There is little doubt that a compound cake thus deriving its oil largely from linseed is superior in this respect to those in which the oil is not linseed oil, but has been derived from rice, maize, and similar materials.

The impurities to which linseed thus fed whole is mostly subject are weed seeds and dirt, but, as stated, the seed employed is mostly of very clean character, and it is seldom that objection has to be taken to it.

The feeding properties of linseed depend mainly upon the oil and the albuminoids it contains. In well-matured linseed the greater part of the nitrogenous matters are true albuminoids. Linseed also contains pectin, mucilage, &c., which give to it its 'jelly-forming' properties.

The following analyses may be taken as fairly representative of the principal classes of linseed now imported:—

	Calcutta.	Russian.	Argentine (La Plata).
Moisture	8·0	9·5	8·5
Oil	39·0	33·0	37·0
[1] Albuminous compounds	21·0	23·0	22·5
Mucilage, digestible fibre, &c.	20·5	24·0	21·5
Woody fibre	7·0	6·5	6·5
Mineral matter (ash) ...	4·5	4·0	4·0
	100·0	100·0	100·0
[1] Containing nitrogen ...	3·4	3·7	3·6

Considered as a manurial substance, linseed is inferior to linseed cake, the oil having no manurial value. Despite this, it stands high in the table of unexhausted manure values. In Voelcker and Hall's Tables the compensation value for each ton of linseed consumed is given as follows:—

Last year.	Second year.	Third year	Fourth year.
30*s.* 6*d.*	15*s.* 3*d.*	7*s.* 7*d.*	3*s.* 9*d.*

The mineral matter (ash) contains about: phosphoric acid, 1·54 per cent; potash, 1·37 per cent. [J. A. V.]

Linseed Cake.—Of all the purchased foods used on the farm there is perhaps none more general or more highly esteemed than linseed cake. It is at once recognized as a most useful food for all classes of stock, and especially valuable for fattening purposes, and also as being, on the whole, the safest kind of artificial food to give to stock whether young or old.

Linseed cake is the residual product left from the crushing of linseed, the oil being extracted for its commercial uses (see preceding article), so that the cake has really to be considered as a bye-product. Its price is, therefore, dependent in great measure on the price obtainable for oil in the market, as also upon the supply of seed available. Frequently, however, so much is the cake esteemed that its manufacture may become the primary consideration.

In the previous article on linseed, reference has been made to the different kinds of seed used and their countries of origin, together with particulars as to the varying quality of the seed and its chief characteristics. These have importance as regards the cake produced, certain kinds of seed, *e.g.* La Plata, being specially esteemed for giving a 'soft' cake, high in albuminoids. Still higher in albuminoids is cake made from Russian seed, while Indian seed gives the lowest albuminoid contents. Further, the freedom of seed from impurities makes a considerable difference as regards the cake obtained and the need of extra cleaning of the seed in order to produce a 'pure' cake. In this respect Riga seed and Black Sea seed are those which present the most difficulty.

The centre of the linseed-cake trade—as with oilseeds—is Hull; but of late years there has been a considerable extension in the up-country mills, and now not only Liverpool, London, Bristol, Plymouth, and other seaport towns produce linseed cake largely, but inland towns such as Leeds, York, Driffield, Lincoln, Gainsborough, Ipswich, Gloucester, Maidstone, and Rochester contribute their share to the output. A syndicate—the British Oil and Cake Mills, Ld.—controls at present about one-half of all the cake mills in the country, and regulates to a great extent the supply, the price, and the quality.

The process of manufacture of linseed cake has been already dealt with in the preceding article, and it only remains to be said, on this head, that the percentage of oil left in the cake after crushing of the seed fixes the relative value when conditions of purity are alike. In the earlier days, and before the Anglo-American presses came into regular use, the country mills had the old-fashioned presses, and turned out a cake which was rightly esteemed because of its containing a good percentage of oil, and for being 'soft' in comparison with the hard-pressed 'American' cakes, as they were called. The country-made cake seldom had less than 11 per cent of oil, while the 'American' cakes might have only 7 or 8 per cent. This virtue attaching to the home-made cakes was, however, one rather of necessity than of design. Now this is all altered, and the new presses are almost universal. Along with this change, and with others introduced by the syndicate spoken of, has come about a closer regulation of the manufacture, and it is now quite possible to turn out a linseed cake with almost any required percentage of oil from 6 or 7 per cent up to 12 and 13 per cent or even more. For a long time about 12 per cent was regarded as the oil-content of a high-class linseed cake, 10 per cent or so for an average good quality, and 8 per cent or less for a low-quality cake. From a large number of analyses made, the table below may be taken as representing the average quality of the three different classes.

A reduction in the oil percentage is followed, of course, by a raising of the other constituents, and the hard-pressed American cakes were generally rich in albuminous compounds, and on this account were much in favour for the winter feeding of young growing stock, as distinguished

	High Quality.	Average Good Quality	Low Quality.
Moisture	11·5	12·0	12·5
Oil	12·5	9·5	7·5
[1] Albuminous compounds	31·0	28·5	30·0
Mucilage, digestible fibre, &c.	32·0	35·5	34·5
Woody fibre	7·0	8·5	9·0
Mineral matter (ash) ...	6·0	6·0	6·5
	100·0	100·0	100·0
[1] Containing nitrogen ...	4·9	4·5	4·8

from stock that were being fattened off, and for which a cake rich in oil was more desirable. The lower price at which these cakes were sold was also an advantage. Up to the passing of the new Fertilizers and Feedingstuffs Act (1906) it was usual to sell linseed cake by sample or as being of a particular brand or manufacture the quality of which was fairly known. Some makers were willing to sell with a definite guarantee of oil, but the practice was not general. The Act of 1906, however, introduced the condition that in the sale of all artificially prepared foods—among which linseed cake was, of course, included—the percentages of oil and albuminoids should be stated, this having the force of a guarantee. Linseed cakes are, accordingly, now always sold with a guarantee of oil and albuminoids, and the manufacturers have adapted themselves to the new ways, with, it may be said, comparatively little difficulty, so that one has but to ask for linseed cake with 8, 9, 10, 11, or other percentage of oil, and he can be supplied with it within very reasonable limits.

The percentages of oil and albuminoids are, however, not the only desiderata in a linseed cake, or the only requirements of the Act, for a cake must also be what it is described, viz. 'linseed cake'—that is, it must be pure, and made from linseed only, and not mixed with other ingredients. Over the term 'pure' and what shall be understood by it, as applied to linseed cake, there has been much discussion. But in practical working, as also in applying the Fertilizers and Feedingstuffs Act, there has been little real difficulty experienced. As long ago as 1887 the Royal Agricultural Society of England, through their consulting chemist, set out what, in their opinion, constituted a 'pure' linseed cake, and these requirements (which it will be well to set out) have been universally accepted, and have been adopted as the 'R.A.S.E. standard', according to which manufacturers and traders are willing to sell. Among others, the British Oil and Cake Mills, Ld., adopt this standard, and its introduction has been found to be of the greatest benefit, and to introduce but little difficulty in practical working. According to it a linseed cake should satisfy the following requirements:—

1. That it be made from sound seed of not less than 95 per cent purity, subsequently well screened.

2. That it contain no ingredients of a poisonous or deleterious nature.

3. That it be entirely free from admixture of any kind.
4. That it contain not more than 2 per cent of sand.
5. That it be sold in good, merchantable condition.

These requirements have, as stated, been found to work extremely well. In the case of a seed like linseed there is always a certain amount of what is called 'natural impurity', and no reasonable person would expect absolute purity, or more than that reasonable care should be taken, by screening, to remove these impurities, consisting, as they do, mainly of weed seeds and earthy matter. In earlier times the manufacture of linseed cake from dirty seed, or from seed purposely adulterated, was very common; but by the introduction of the Fertilizers and Feedingstuffs Act (1893) great good was done, inasmuch as it laid down that feeding materials sold under specific names should correspond to the recognized descriptions given of them. As a consequence, it is comparatively seldom now that a cake sold as 'linseed cake' does not conform to the definition of 'pure' as laid down. Attempts have been made, however, to evade the Act by the use of qualifying phrases, such as '95 per cent pure', 'made from linseed as imported', 'made from linseed with natural admixture', &c., but these are happily disappearing, and if a purchaser will but insist on having cake invoiced to him as 'linseed cake' he will generally be secure. At one time the term 'oil-cake' was used as synonymous with linseed cake, but this is a misleading term, and now means practically an 'impure' linseed cake.

The principal impurities in linseed cake are weed seeds and other grains with which the linseed is grown, or with which it gets mixed in transit, as also earth, from which it is very difficult to separate it entirely, even by careful screening, so that an outside margin of 2 per cent has still to be allowed. The seed as it comes over to this country is usually sold on a basis of 95 per cent pure, or sometimes even of 97 per cent. To oleaginous seeds, not linseed, a certain allowance is further given. The principal impurities found nowadays are: rapeseed, wild-mustard seed, various species of Polygonum, Corn Cockle, Spurry, Chenopodium, and Gold of Pleasure (*Camelina sativa*). Others less frequent, and in most cases purposely added for the purpose of adulteration, are earthnut, hempseed, niger seed, sesamé seed, safflower seed, &c. In earlier times, when systematic adulteration of linseed cake took place, in addition to the above materials others were used, such as mill sweepings, wheat screenings, rice and oat husks ('shudes'), rice meal, bran, ground olive kernels, sawdust, and an article which went in the trade by the name 'buffum', and which consisted of the weed seeds removed in the screening of linseed, together with extracted rapeseed or rape refuse. Occasionally, through carelessness, distinctly poisonous seeds such as castor-oil bean find their way into linseed cakes.

The principal constituents of value in linseed cake are the oil and the nitrogenous bodies, these latter being largely albuminoids. The 'albuminoid ratio' is 1:2·3. Linseed cake when pure contains no starch, the iodine test for starch giving a handy means of determining its freedom from starchy admixtures. Linseed cake also contains pectin and mucilage, the latter giving rise to the jelly-like consistence formed when linseed cake is stirred up in warm water, and which makes the cake a suitable food for using as a 'porridge', more particularly for calves. Ninety-six per cent of the nitrogen is present in the albuminoid form, and of the total nitrogenous matters 86 per cent are digested, 90 per cent of the fat and 80 per cent of the soluble carbohydrates, with 50 per cent of the woody fibre. Linseed cake is thus a very digestible and consequently valuable food. The mineral matter (ash) contains nearly 2 per cent of phosphoric acid and 1·4 per cent of potash, and, considered in the light of its manurial value, after being fed to stock, it ranks high in the table of compensation values. While inferior to decorticated cotton cake, it stands next in order, the valuation per ton consumed being, according to Voelcker and Hall's revision of Lawes and Gilbert's Tables, as follows:—

	Last year.	Second year.	Third year.	Fourth year.
	s. d.	s. d.	s. d	s. d.
Linseed cake ...	38 7	19 3	9 7	4 9

Linseed cake is never used direct to the land as manure, except, possibly, in the case of damaged cakes, but is either fed on the land to sheep, or given to cattle in the yards, and, less generally, out on grass.

If well made, and not containing excessive moisture, linseed cake will keep quite well when stored in a dry, well-ventilated place, and in this respect it is better than undecorticated cotton cake.

It is a favourite food for sheep when feeding off roots on the land, about 1 lb. per head being given daily. A common practice in some parts of the country is to give sheep on roots a mixture of linseed cake and undecorticated cotton cake, half and half. For calves, linseed cake is perhaps the first artificial food that they will nibble, and it is also about the safest thing to give them.

Its value for cattle is so well understood that it is only necessary to remark that many stock-feeders hold to it whatever its price may be, and are ready to maintain that nothing can adequately take its place. Certain it is that nothing will put the desirable 'bloom' on cattle that are being 'finished off' as will a good linseed cake rich in oil. A general feed of it for cattle is 4 lb. per head daily to begin with, and gradually increasing to 6 lb., 8 lb., and even to as much as 10 lb. per head daily towards the time of the stock going away. For winter feeding of younger and store stock, the lower-priced cakes, less rich in oil but higher in albuminoids, are more generally used, and in lesser quantity. Linseed cake is also given to dairy cattle, but more sparingly in the case of milking cows than with feeding animals, as its use in any excess is apt to produce a 'soft' and somewhat 'oily'

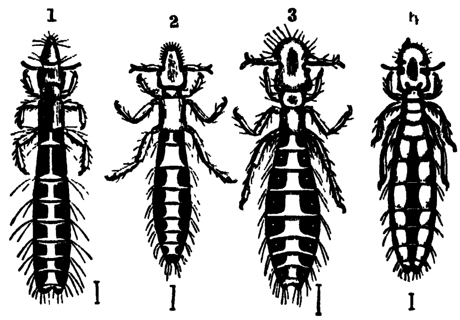
butter. Horses also have occasionally a little linseed cake given to them.

Altogether, linseed cake is one of the most generally used and most valuable purchased foods of the farm, as well as being one of the safest; and it is satisfactory to note that so great an improvement in its supply and quality has been effected (largely by the action of the leading agricultural societies, assisted by legislation and the co-operation of the trade) within recent times. From being an article which was formerly the common medium for adulteration of every kind, the purchase of pure linseed cake has now come within the reach of all. It is still necessary, however, to warn purchasers to stipulate for having 'linseed cake' invoiced to them pure and simple, and without any qualifying prefixes such as '95 per cent', and to avoid altogether 'oilcake', a term now synonymous with 'impure linseed cake'. [J. A. V.]

Linseed Oil.—This is the oil expressed from linseed (*Linum usitatissimum*), and is obtained in the process of linseed-cake manufacture. It is but little used as a material by itself in agriculture, its uses being mainly industrial, viz. for paint and varnish manufacture and in soap and linoleum making. The property which it possesses of being a 'drying' oil fits it especially for the making of paint. To a small extent it is employed on the farm, but mostly for medicinal purposes. Occasionally it is poured over chaff and other chopped fodder with the idea of making this more palatable, and of supplying a relish to fattening animals. Its laxative effects, however, oblige its use with caution. It has also been suggested as a medium for replacing the fat removed from milk, the skimmed or separated milk being churned up with the oil, and the product being used for calf-rearing. The yield of oil, its quality, and its suitability for different industrial purposes depend upon the kind of seed employed, and to some extent, as explained in the article LINSEED (which see), upon season. The value of linseed oil as a feeding material is much higher than that of cotton or other vegetable oils; and this is of material importance in the case of compound cakes, which are not unfrequently stated to contain oil 'mainly linseed oil', but in which too frequently the oil is derived chiefly from rice, maize, and other grain of feeding value much inferior to that of linseed. [J. A. V.]

Lip, Injuries to.—The lips of the domesticated animals differ greatly in their offices and mobility, and injuries to them are therefore of unequal importance. They are the organs of prehension in the horse, and any injury is a hindrance to the gathering of food. Nails in stable walls and mangers, splinters or other foreign bodies in the food, give rise to wounds and abrasions which are often kept irritable by the insinuation of particles of food, such as husks of corn or short straw chaff. The improper use of the twitch, of severe curbs, and of port bits causes paralysis of the lips, and difficulty in seizing provender. Cattle and sheep have very thick and immobile lips, as they seize their food with the tongue, and the prominent snout of the pig saves him from injuries to the lips such as horses encounter. Falling on the mouth—'pecking' in hunting parlance—is a source of injury to the lips whereby they are often seriously cut by hard bodies outside, or by the teeth on the inner aspect. Sheep driven on dusty roads or feeding on coarse herbage suffer from sore lips. *Treatment* consists in removing all sources of irritation, while nature acts in the most generous manner in repairing injuries connected with the membranous side; and the skin may be sutured or painted with friar's balsam, solutions of boracic acid, or alum, and the animal meantime fed upon 'slops' until the functions of the injured lips are restored. [H. L.]

Lipeurus, a genus of biting lice (Mallophaga). They do not, like the Pediculi, suck the blood of their hosts, but feed upon the substance of the feathers, their jaws being adapted for biting. The following species are of frequent occurrence:—



Feather Lice

1, *Lipeurus baculus*; 2, *L. jejunus*; 3, *L. polytrapezius*; 4, *L. squalidus*, all females (magnified)

L. baculus (the Pigeon Louse).—Head elongated, truncated at the base, tapering towards the nose, bright-chestnut; eyes lateral, minute, and before them, on each side, in a notch are inserted the slender five-jointed antennæ; third joint hooked in the male; prothorax suborbicular and chestnut-coloured; abdomen very long, dull white, with dusky patches down the sides; abundant on all varieties of pigeons.

L. jejunus (the Goose Louse) is pale yellowish-white, with dark, squarish patches down the sides. The legs are rather long, and are dusky above. It is found on domestic and on wild geese.

L. polytrapezius (the Turkey Louse) is pale yellowish-white, margined with black; the head is broad, cut out on each side, with a black spot before the eyes, and a band before the antennæ; abdomen with a line of large ashy-brown spots down each side; the tip whitish. It is found on the wings of turkeys.

L. variabilis (the Louse of domestic-fowls) is smooth, shining, dirty white; the head is broad, rounded before, and with a black margin, a spot at each eye, and two black curved lines at the base. The thorax and abdomen are margined with black, and the latter has a brown stripe down the back. It is abundant amongst the wing-feathers of domestic fowls. [J. C.] [C. W.]

Liquid Manure.—Liquid manure is a term variably applied to the drainings of farmyards, manure heaps, &c. Strictly speaking, it comprises the liquid portion, or urine, of the excrements of farm animals, together with such matters from the solid excrements as are readily, or become, when kept in a manure heap or in a covered yard, soluble. As set out in the article FARMYARD MANURE (see this art.), the liquid portions, or urine, contain the bulk of the nitrogenous and potash salts, as also the soluble phosphates, derived from the food given to stock. These comprise the urea, uric acid salts, and humous compounds which, on fermentation of the heap, are removed as a dark-coloured liquid. In practice, however, liquid manure means something very different from the concentrated liquid excrements, for whenever manure heaps are exposed uncovered, or when manure is made in open yards, the rain coming down dilutes the soluble matters and removes others by constant washing, so that the liquid manure which runs down into the drains consists of a liquid of very varying strength, according to the amount of rain which has fallen on the manure. It is usual in a farmyard to have the bottom sloping slightly to the centre, where is placed a sink, this connecting by a pipe with a bricked chamber in which the liquid manure collects. From this chamber the liquid can be pumped out as the chamber gets filled, and may then be carted away in a specially constructed liquid-manure cart, and so distributed over the land. Another way of utilizing the urine is to have a pump connected with the liquid-manure tank and to pump back the liquid over the manure in the yard. Liquid manure will vary in quality according to (1) the kind of stock producing it, (2) the food given to the animals, (3) the amount of dilution it receives from rainwater, (4) the length of time the manure has been kept. The urine of milking cows and of young growing stock is less rich than that of fattening bullocks, and that of cake-fed animals is richer than that from others. Indeed there is good reason for believing that the bulk of the nitrogen from highly nitrogenous foods like cake finds its way into the urine, and, if the latter be wasted, the value of cake-fed manure as against ordinary farmyard manure will largely disappear. By feeding cake on the land direct to sheep there is the best opportunity of conserving this advantage.

The urine of sheep and horses is more concentrated than that of cattle and pigs. The urea of the urine speedily undergoes change on keeping, being attacked by different organisms and being converted into carbonate of ammonia, this in turn breaking up into ammonia and carbonic acid. This change is so rapid that in liquid manure and in the drainings of manure heaps urea as such is seldom found. Liquid manure is alkaline on account of the presence of the carbonate of ammonia so formed, and because of the soluble potash salts it contains, and this alkaline liquid has the power of dissolving out from the straw and the solid excrements some of the humous compounds, these giving to liquid manure the well-known dark-brown colour which it possesses.

Allowing the liquid manure to run to waste accordingly involves the loss of the most valuable and most readily available constituents, and this should be, as far as possible, guarded against. Feeding cattle in boxes or pits with cemented floors and sides has the great advantage that the urine is conserved much better, and that there is no draining away of it or washing by rain. When manure is so made the urine is absorbed by the litter, and the manure is obtained in a compact mass with comparatively little loss.

Liquid manure, when ordinary good care has been taken to prevent it from being wasted, is too strong for direct application to the land, and might burn up grass or corn crops. It is generally diluted with about an equal volume of water and so used. The best way to employ it is to pour it over grassland which is intended for hay, and it can be put on the grass at any time through the winter and early spring. It tends to produce rankness of growth and to encourage the growth of the stronger grasses, thus giving a coarse quality of hay.

Liquid manure is not, as a rule, used on arable land, nor is it suitable for application to clay land, but on a light sandy land, wanting in organic matter, it may be employed to advantage. Being composed of soluble salts it is mostly ready for the immediate nutrition of plants, and does not require to undergo much decomposition, as do the solid portions of dung. The difficulty of its application to arable land is that it has frequently to be carted out at a time when crops are not ready to receive it, and also because of its readily passing away into the drainage. Hence it is principally used for grassland, where the losses are not so great, and which is ready at almost any time to receive it.

The composition of liquid manure varies so greatly according to the circumstances under which it is produced that it is not possible to put out any analysis which will fairly represent its general composition. When free from washing of rainwater, &c., it should be, of course, little more than the urine of the animals producing the manure, together with a certain amount of the humous matters removed from the litter and solid excrements. But, as pointed out, this state of things seldom or never prevails. When dung is made in feeding boxes or pits the urine is all absorbed, and this holds good to a large extent also in the case of a covered yard, though the loss by evaporation will be greater. Where, however, yards are only partly covered or are quite open, the composition of the liquid manure may show enormous variations. The quality of it will be improved by taking care to keep apart the water that runs off the roofs of adjacent sheds and buildings; but this is a matter but little attended to as a rule, and what runs into the liquid-manure tank is, at best, a liquid of very uncertain character, but containing ammonia (present mainly as carbonate of ammonia and humate of ammonia), potash as carbonate, chloride, and sulphate, phosphoric acid as phosphates of lime and magnesia, together with a considerable amount of chloride of sodium. [J. A. V.]

UTILIZATION OF LIQUID MANURE.—The use of manures in a liquid state includes more than the simple use of liquid manure, as generally understood. The object is in this case the conversion into, and distribution of fertilizers in a liquid form, whereas the ordinary idea of liquid manuring is, the preservation of the waste runnings from cowsheds, buildings, or manure heaps. The subject therefore includes the use of the water drill, in which superphosphate and other substances are distributed by water at the rate of 600 or 800 gal. per acre (see WATER DRILLS). It also carries us back to the times of Mr. Mechi of Tiptree Hall, who converted the whole of the excrements of his cattle and pigs into liquid manure, by an arrangement in which the animals stood upon sparred floors, which were daily sluiced with water. The liquid was received in capacious tanks, from which it was pumped into a system of pipes and hydrants extending over his entire farm, and from thence distributed by hose over growing crops. The quantity used varied from 4000 to 6000 gal. per acre, and the application was repeated several times during the growing season.

The subject of liquid manuring is closely related to the management of sewage farms, for what is sewage but a dilute form of liquid manure? (see SEWAGE).

Liquid manure is, as stated in the previous section, better adapted for grassland than for arable fields, and, if possible, should be conveyed over the surface by gravitation from a higher level, rather than by cartage or direct pumping. In point of fact, as has also already been indicated, the liquid is better absorbed by some form of litter or earth, than allowed to drain into a receptacle; and it has been found, in countless cases, that farmers allow their tanks to remain charged, and do not empty them regularly as was intended by their landlords. By the use of cattle boxes and covered buildings, or small, well shedded and spouted yards, the liquid can be absorbed and carted in a solid form with the dung; and this is less troublesome than collecting it in a tank, and equally effectual. To periodically pump liquid manure from a tank and to pour it over solid manure savours rather of model farming than of practical agriculture. There are also some disadvantages in applying liquid manure to land. It must necessarily be distributed close to the buildings, usually on grassland, and cannot be used with advantage in dry weather, nor yet in the height of the growing season. While, therefore, the regular emptying of the tanks is necessary, a favourable time for the purpose may not occur for several weeks.

It must not, however, be thought that the storage and application of liquid manure is useless, as there are situations in which it may be carried out with advantage, as, for example, on suburban farms where litter is scarce, and milk production is a principal object. The system is eminently cleanly, for nothing can be better from a sanitary point of view than washing the passages of cowhouses with a copious supply of clean water twice daily, and brushing the liquid manure into channels, from which it is delivered into a tank. This plan was adopted by Mr. Isaac Newton near St. Albans, and was copied by the writer of these remarks. It is especially suitable for localities where the water table lies near the surface, and where tube wells may easily be put down at any point, and furnish a limitless supply of water with the least possible trouble. Such a plan would naturally commend itself to milk customers, or to inspectors, as highly satisfactory. It is true that moss litter or dry earth can be used instead of water with good effect, but for leaving a bright and clean gutter and passage, between rows of cows, nothing can beat a plentiful supply of water followed up by a stiff broom. Where straw commands a high price, the amount of litter used is naturally reduced to the narrowest possible limits, and it is in such circumstances that liquid-manure tanks are most esteemed.

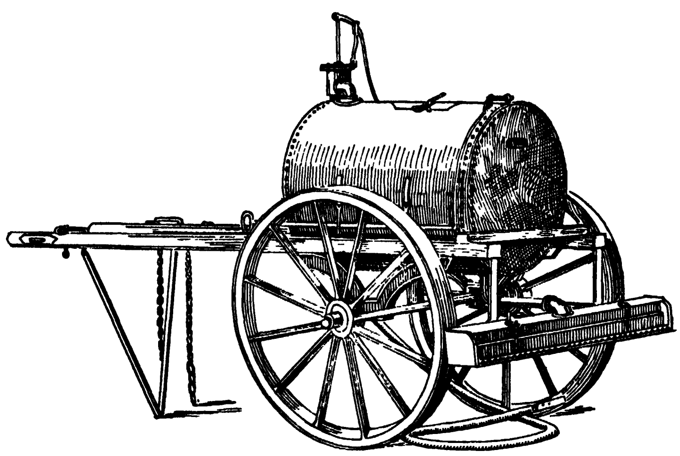
No one doubts the value of liquid manure, for it is much more quickly available for vegetation than solid manure. Not only did Mr. Mechi obtain extraordinary results from its use, but, at the same period of activity in agricultural matters, Mr. Kennedy of Myremill, and Mr. Telfer of Kinning Park, both in Ayrshire, produced phenomenal crops of Italian rye grass from its use. These results were extraordinary, as Mr. Kennedy grew 70 tons per acre, and the united cuttings of rye grass, if laid end to end, grown by Mr. Telfer, measured 14 ft. 3 in. in length! In these cases the liquid manure was conveyed in pipes to every part of the farm, and distributed by hose from hydrants. These results, which were obtained during the middle years of the last century, do not appear to have induced many to adopt the system. They are, however, indisputable, and could no doubt be reproduced. Probably the paralysing effect of low prices has checked enterprise, but there was always, even in those prosperous times, a deep-rooted feeling that the expenditure, initial and current, was beyond the value of the produce.

Very similar results have been recorded on sewage farms, and the writer has himself measured Italian rye grass 7 ft. 9 in. long, being cut on the Croydon sewage farm in the days of Mr. Marriage. On sewage farms it is of importance that the liquid should be distributed by gravitation rather than by pumping; and the same is true with regard to liquid manure. Economically it could scarcely pay to use an engine to pump liquid manure over arable land, unless in the case of crops of exceptional value. On the other hand, the systematic distribution of liquid manure by irrigation from an eminence over sloping grassland, is quite to be recommended. This should be done in wet weather, as liquid manure will scorch growing vegetation in dry seasons. This is easily seen by daily observation, for cow's—or in fact any—urine temporarily kills grass. This is a serious difficulty, and must have been known and guarded against by enthusiastic liquid manurers in years gone by. It is due to the evaporation of the water, and the consequent concentration of the manure upon the herbage, and it is also partly due to the strength of the liquid, which

may be so diluted as to do no harm. It is, however, demonstrable that even a weak solution must become supersaturated under the influence of evaporation, and hence the importance of applying liquid manure at a time when rain will wash it from the foliage, and convey it to the roots. It will be seen from these few remarks that the waste of liquid manure should in all cases be avoided; but rather by preventing the access of rainwater than by the use of underground tanks. From this point of view it would seem as though the liquid-manure tank belonged to an earlier epoch than the present, and that it has been replaced by covered buildings in which the liquid excrements of animals are preserved in the mass of well-made farmyard manure. On the other hand, there are circumstances in which, owing to scarcity of litter, or the requirements of perfect cleanliness, as in the case of cow-keeping, there is still room for these appliances. Neither can we entirely disregard the injurious effects of liquid manure upon iron tanks or carts used in its distribution. These are expensive to buy, and, unless very carefully looked after, are soon rendered useless. Perhaps the general inconvenience of applying liquid manure at the right time, and the liability to overlook its distribution on account of other forms of labour, are among the principal causes why the liquid-manure tank and the liquid-manure cart have never found much favour among farmers. [J. Wr.]

Liquid manure is particularly beneficial when applied to plants about to flower or to perfect their fruits; thus what liquid manure is available may be most advantageously devoted to vine and peach borders, tomatoes, cucumbers, chrysanthemums, and to fruit trees which have set a large crop of fruit. Consisting largely of urine, liquid manure is very variable in composition and value, and in its application the golden rule is, *weak and often*. Do not apply it when the soil is dry, or it will run through and do little good. It is a good plan to vary the application; thus farmyard liquid manure might, for example, be applied one time, and nitrate of potash and phosphate of potash, in the proportion of ½ oz. of each per gallon of water, the next. Soot water in the proportion of 6 qt. of soot to a hogshead of water has an excellent effect upon the foliage of plants; and many gardeners who are practical rather than severely scientific, have great faith in weak solutions of sheep's dung and poultry dung, alternated with applications of plain water. [W. W.]

Liquid-manure Carts.—Liquid-manure carts are tanks or barrels mounted on wheels or wheeled frames, and are generally provided with perforated troughs or other means to distribute the manure equally over a wider stretch of land than it would reach if allowed to run from one hole or jet only. A serviceable liquid-manure cart can be made by mounting a barrel such as a wine pipe on a simple cart frame, and attaching a perforated trough of the desired length, placed across the wheel track at the rear to receive the liquid from the outlet hole. The outlet hole should have a screen before it to arrest floating straw or other matter which might block the outlet. A simple valve or other device to regulate the outflow should also be provided. A liquid-manure drill is the most elaborate form of liquid-manure cart, being fitted with dredgers to raise the liquid in uniform quantity, and then disperse it; but for liquid manure such as is taken from drainage from cow byres and manure pits, gravitation is practically always relied upon. The accompanying illustration shows all the requirements of a high-class cart, with distributor, pump, and hose. By removing the distributor an ordinary water cart is provided. The carts are made in sizes to hold from 130 gal. to 240 gal. [W. J. M.]



Liquid-manure and Water Cart (Reeves & Son, Westbury, Wilts)

Liquid-manure Tank. See art. TANKS.

Liquorice. See art. HERBS AND HERB INDUSTRY.

Literature, Agricultural.—The literature of agriculture is ancient, immense, and with few exceptions has proved comparatively unimportant in its effects upon the practice of tilling the soil. Epoch-making works like Newton's Principia or Darwin's Origin of Species are practically absent from the literature of agriculture. The complexity of the subject, the slowness with which the results of trial and experiment are obtained, and the impossibility of accurate observation while the foundations of biological and chemical science were yet unlaid, have rendered the great majority of agricultural books mere interesting accounts of manners and customs rather than stepping-stones to superior results.

Nevertheless no occupation by which man earns his bread has been so much written about. From 1200 to 1800 A.D. nearly 500 books and pamphlets on agriculture and horticulture were published in the British Isles, and since the beginning of the 19th century considerably more than that number have been produced. Different writers have written several volumes wholly devoted to discussion and description of the bibliography of agriculture, and any attempt to vie with them is impossible in these pages. In the scope of this article it is only possible to mention the most important publications and arrange them in chronological order, as those which mark a distinct advance in the improvement of agricultural methods.

The literature of agriculture began many centuries before the Christian era, and Varro, a Roman writer in the last century B.C., speaks of more than fifty authors who might be consulted on the subject of agriculture, all of whom were Greeks except Mago the Carthaginian. Xenophon wrote on agriculture, and, it is said, even gave lessons. Hesiod managed a farm and wrote about it, describing the soil as bad in winter, hard in summer, and never good (how like the Scotch clay that 'greets a' winter and girns a' summer'). Rome was rich in writers on rural economy, and among those whose writings have been preserved are Cato, Varro, Virgil, Columella, Pliny, and Palladius. Cato's De re Rustica is the oldest Roman work on agriculture. Varro's treatise with the same title is chiefly interesting as the source of much of the information in Virgil's famous classic the Georgics. Pliny's Natural History, as the encyclopædia of his day, contained much agricultural information; and finally Palladius wrote what is described as a dull poem on rural life in fourteen books, a compilation from most of his predecessors in agricultural authorship. From the time of Palladius, about 400 A.D., to Sir Walter de Henleye, about 1250, there is an absolute dearth of agricultural documents save those which may have been compiled from the writings of the Roman and other authors already mentioned. With Sir Walter de Henleye's Treatise on Husbandry, a description of estate management written in French, begins the literature of British agriculture. In the following century Robert Grosseteste, Bishop of Lincoln, wrote a Set of Rules upon Estate Management, also in French. In 1523 appeared the first English treatise on practical farming. This, The Boke of Husbandrie, was written by John Fitzherbert, lord of the Manor of Norbury, and not by his brother Anthony as has been generally believed. Fitzherbert is regarded as the father of English husbandry, and his book, which ran through eight editions, remained for more than a century a first-class manual of farming. The Boke of Surveyinge, also by Fitzherbert, is the first on the subject in the English language. A Hundreth Good Pointes of Husbandrie by Thomas Tusser, published in 1557, is the next agricultural treatise, followed by Five Hundreth Pointes of Good Husbandry. Those celebrated books, widely read in their time, are rhyming precepts and farming directions rather than original observations upon agriculture. Several writers of lesser note published books after Tusser, but none of importance worth recording till we come to the manuscript of Sir Richard Weston issued by Samuel Hartlib. Fitzherbert wrote the first treatise on agriculture, but Sir Richard Weston laid the foundations of modern agriculture by introducing rotation of crops founded on the cultivation of clover, flax, and turnips. His only work, A Discourse of Husbandrie used in Brabant and Flanders, was published by Samuel Hartlib. About this date, the beginning of the 17th century, the practice of agriculture had greatly improved, and landowners had discovered that the proper cultivation of their estates was a profitable employment. Samuel Hartlib, a noted writer, was born in Poland, but came to England when about twenty-eight years of age. He does not seem to have farmed, but he had some knowledge of farming, and about 1645, besides publishing Sir Richard Weston's Discourse, he issued his Legacie, or Enlargement of the Discourse. He wrote several other volumes, of which the Reformed Husbandman and the Complete Husbandman are perhaps the most important. From his books we learn that sainfoin, clover, lucerne, and trefoil had come into cultivation, and the sowing of grass seeds (the bottoms of hayricks) foreshadowed the beginning of alternate husbandry. Hartlib was the first to write a treatise on the establishment of agricultural colleges, though Thomas Tusser had suggested the same thing. Towards the middle of the 17th century agriculture made great progress: holdings became larger; a class of educated men made farming a commercial pursuit; clover cultivation became general; hedges were introduced into Scotland and Ireland, and extensive schemes of embanking and drainage were carried out. Much of this improvement must be accredited to Gervase Markham (1568 to 1637), who was a voluminous writer on agriculture. His best-known books are Cheape and Good Husbandry, Farewell to Husbandrie, and The Perfect Horseman. Markham wrote plays and poetry as well as innumerable books on agriculture, and seems to have been a remarkable man. About this time, 1642, Sir Cornelius Vermuiden, a Dutchman, and colonel in Cromwell's army, wrote a Discourse touching the Drayning of the Great Fenns. Another officer in Cromwell's army, Walter Blith, wrote one or two well-known works remarkably well illustrated, and entitled The English Improver, followed by The English Improver Improved. Blith was a great advocate of alternate husbandry and the resting of land in grass for a time.

The 17th was pre-eminently the century during which forage crops were introduced, and Adam or Adolphus Speed, author of Adam out of Eden; Gabriel Reeve, Directions for the Improvement of Barren Lands in England; J. Sha, Certaine Plaine and Easie Demonstrations of Divers Easie Wayes and Meanes of Improving of any Manner of Barren Land although the same be not worth Twelve Pence the acre, &c.; M. Stevenson, with a Discourse of even

longer title, and Sir John Petitus, St. Foine Improved, a Treatise on Grasse called St. Foine, all did much to increase the cultivation of forage crops. Andrew Yarranton, sometimes called the father of English political economy, was the most practical and sensible of forage advocates. His book, The Great Improvement of Lands by Clover, or the Wonderful Advantage by the Right Management of Clover, would scarcely be out of date now. Passing over some writers of minor note we come to The Countryman's Treasure, by James Lambert, 1676, a very full description of diseases of live stock and their cure. A number of unimportant books were issued between 1676 and 1696, and the century closes with the publication at Edinburgh in 1697 of Husbandry Anatomised, or an Inquiry into the Present Manner of Tilling and Manuring the Ground in Scotland. This rare and—from the collector's point of view—valuable book was written by James Donaldson, and is the first agricultural treatise of any note on Scotch farming. In 1707 appeared The Whole Art of Husbandry, by John Mortimer, a notable book in respect that it ran through several editions and was translated into Swedish. About ten years later, Richard Bradley, F.R.S., professor of botany at Cambridge, began issuing the many volumes on agriculture which bear his name. His Survey of Ancient Husbandry and Complete Body of Husbandry are examples of clear arrangement, and are among the first attempts to treat agriculture as a science. In 1718 Stephen Switzer published several books of considerable note, and one of them at least is nowadays of some value, as it contains a list of seeds and their prices in 1732 or 1733. In 1724 there appeared a book which was a praiseworthy attempt to benefit the farmers of Scotland. This was a Treatise Concerning the Manuring of Fallow Ground, &c. The authors were the Honourable Society for Improving in the Knowledge of Agriculture.

We come now to the issue of a book which if any deserves the name of epoch-making. It is called An Essay on Horse-Hoeing Husbandry, and its author was Jethro Tull. It was published in 1731, and the full title of this agricultural classic is The Horse-Hoeing Husbandry, or an Essay on the Principles of Tillage and Vegetation wherein is shown a method of introducing a sort of Vineyard Culture into the cornfields in order to increase their Products and diminish the Common Expense by the Use of Instruments described in Cuts, by J. T. This book has probably had more influence on the systems of farming in Great Britain than any other. Its chief merits were the advocation of drilling instead of broadcasting seed, the use of horse-drawn implements working between rows of plants, and the profit derivable from deep or thorough tillage. In 1739, a year before his death, appeared a supplement to his first book. Those two volumes have laid the foundation of a name which, according to Arthur Young, will 'probably last as long as the globe we inhabit'. Jethro Tull's is the first and greatest of several great names of agricultural writers who flourished in the 18th century. Between the days of Jethro Tull and Arthur Young we find a bevy of Scotsmen, of more or less distinction, writing upon agriculture. Dr. Andrew Blackwell of Aberdeenshire wrote The Practical Husbandman, 1757; and in the same year Dr. Francis Home, professor of materia medica in the University of Edinburgh, published The Principles of Agriculture and Vegetation. Two well-known books appeared in 1762 and 1778 by Adam Dickson, the minister of Dunse, in Berwickshire. The first, a Treatise upon Agriculture, is reckoned one of the best books of its time upon tillage; and the second, The Husbandry of the Ancients, is the great authority upon that subject to the present day. In 1765 Dr. George Fordyce, a London physician but an Aberdonian, published The Elements of Agriculture and Vegetation.

The first of Arthur Young's many volumes appeared in 1767. Young's writings are agricultural classics, and entitle him to the distinction of being the greatest of British agricultural authors. Not only were his works of practical value as manuals of agriculture, but some of them are vivid pictures of his time, and invaluable to the historian. Moreover, he was a master of English prose, and his books are not merely descriptions, but literature. Among the twenty-nine or thirty publications of which he was the author, the best known are the Farmer's Kalendar, 1770, of which over twenty editions have been published; and The Annals of Agriculture and other useful Arts, which he edited, and to which he contributed. George the Third under the name of Ralph Robinson contributed to the seventh volume of the Annals. The accounts of his various Tours in England and Ireland and his Travels in France are also very well known. The publication of Arthur Young's books must have given a great impetus to agricultural authorship, as we find that about 140 writers issued books on agriculture during the last thirty years of the 18th century. The most notable of those up to 1780 were Dr. James Anderson's Essays relating to Agriculture and Rural Affairs, 1775, and a Report on Aberdeenshire, 1794. Dr. Anderson's books, of which there are seven or eight, have the great merit of issuing from the pen of a practical farmer, who farmed 1300 acres with great success in Aberdeenshire for twenty years. In 1779 The Gentleman Farmer, by Lord Kames, an eminent Scotch lawyer, appeared, and held the field for many a day as a great agricultural manual. From 1778 to 1783 a William Marshall issued fourteen books or booklets, of considerable interest as pictures of regional agriculture in several English areas, and of some utility to estate managers of his day. A little and apparently unimportant book was published in 1784 by James Small, a plough-wright and small farmer. It was entitled A Treatise on Ploughs and Wheel Carriages, and it deserves a prominent place in agricultural literature as the work of the famous inventor of the improved or Small's plough. In the same year there came to light a pamphlet called Drill Husbandry Perfected, by James Cooke, the inventor of Cooke's drill machine, for long the

most popular machine for sowing grain and grass seeds. Six years later we enter a period of extraordinary literary activity initiated by the famous Right Hon. Sir John Sinclair, Bart., founder and President of the Board of Agriculture. The great work of the period, the Statistical Account of Scotland, consisting of articles on all the parishes by the clergyman of each parish and completed in seven years, was the idea of Sir John Sinclair, and the achievement by which he will be remembered. Too great praise cannot be given to this collection of information, so vast, so useful at the time, and so valuable to historians of a later generation. The Code of Agriculture written by Sir John himself is one of his best-known books. Following the Statistical Account are innumerable Reports or General Views of this or that county in England or Scotland. A prolific writer on county agriculture was James Donaldson, the author of Modern Agriculture, or the Present State of Agriculture in Great Britain, 1795-6, a useful book. In 1795 a Treatise Showing the Intimate Connection that subsists between Agriculture and Chemistry, and in 1795 the Principles of Chemistry applied to the Improvement of the Practice of Agriculture, were issued. They were written by Archibald Cochrane, Earl of Dundonald, and gave a considerable impetus to the study of scientific agriculture. The remaining literature of the 18th century is only notable as containing Letters to Sir John Sinclair and Arthur Young by General George Washington, first President of the United States of America; and Phytologia, or the Philosophy of Agriculture and Gardening, by Erasmus Darwin, both published in 1800.

In the first dozen years of the last century Dr. Andrew Coventry, professor of agriculture in Edinburgh University, published three volumes; they are not of great value, but they remain of interest as the work of the first professor of agriculture in the British Empire. One of them is a Discourse Explanatory of the Nature and Plan of a course of lectures on Agriculture and Rural Economy. A work of no little importance to agriculture appeared in 1815, viz. A Geological Map of England and Wales and part of Scotland, by William Smith, Surveyor and Geologist. This is the first geological map of England, and its scientific and industrial value can scarcely be exaggerated. About this period greater interest was being taken in agricultural machinery, and several booklets and pamphlets were written on the subject. It is noticeable also that specialism is increasingly predominant in the literature, for example we have a treatise on one breed of sheep, on one species of grass, &c., with the natural result that the periodical literature increases. A book entitled The Elements of Agricultural Chemistry was published in 1813. In this book were embodied the researches of the world-famous Sir Humphry Davy, who for ten years had been professor of chemical agriculture to the Board of Agriculture. The Elements of Agricultural Chemistry laid the foundations of that science, and influenced the development of agriculture to an incalculable degree. Books on sections and subsections of the subject continued to increase, and such pamphlets as The Farmer's Lawyer, by Williams, in 1819, and The Farmer's New and Complete Account Book, are characteristic of the period. Napier's well-known book, A Treatise on Practical Store Farming, by Captain Napier, F.R.S., appeared in 1822, and is one of the first books on hill farming. David Low, afterwards Professor Low of Edinburgh, began to write in 1823, and in successive years published several works on agriculture, one of which, Low's Domesticated Animals of Great Britain, became a textbook on the subject. Professor Low's textbook is further evidence of the development of agricultural literature from general histories and accounts of practices to specific studies of particular subjects. His successor, Professor James Wilson, published a treatise on Farm Crops in two volumes, and to this day it remains the largest and most complete contribution to the subject. In 1823 James Smith began his experiments in drainage, and in 1831 he published his famous book on Thorough Drainage and Deep Ploughing—a book which has done much to increase the food supply of Great Britain. Youatt's standard books on the Horse, Cattle, and Sheep, published by the Society for the Diffusion of Useful Knowledge, are classics, and will long remain valuable sources of information. In the same category is Sinclair's Hortus Graminensis Woburnensis, a thorough discussion of grass and grass growing; and Professor Johnstone's Lectures on Agricultural Geology, the first important study upon that subject.

In 1840, Chemistry in its Relation to Modern Agriculture, by the great German chemist Baron Liebig, appeared, and to this publication, and some others by the same author, we owe much of agricultural science. The first of the famous and invaluable reports from the Rothamsted Experiment Station of Sir John—then Mr. John—Bennet Lawes appeared in 1843, and was followed by others, numbering up to 1905 no less than one hundred and eighty-four.

After the first decade or so of the Victorian period we are dealing with the literature of modern agriculture, which differs widely from the older literature and is fittingly inaugurated by the incomparable Talpa, or The Chronicles of a Clay Farm. This literary gem and sound agricultural treatise was published in 1847 in the Agricultural Gazette and afterwards in book form. Written by C. Wren Hoskyns, one time M.P. for Hereford, it is sound common sense served up in finest English with the sauce of humour, and garnished by the inimitable drawings of Cruickshank.

The agricultural literature of the last half-century is very largely embodied in the literature of the sciences which can be applied to agriculture. As the sciences of chemistry, botany, geology, and zoology, &c., developed on sure foundations they threw more and more light on the operations of farming, and such a book as The Philosophy of Farming, by Erasmus Darwin, suitable for 1800, is superseded by Animals and Plants under Domestication, in 1868, by his more

famous descendant, and such a type of book as the last, in turn gives way to a treatise on Plant Breeding, or the Principles of Breeding at the beginning of the 20th century. The same process of evolution is traceable in all the departments of agricultural science. A textbook of agricultural chemistry is replaced by a book on soils, or on manures or feedingstuffs, and the tendency is to divide and subdivide, so that each separate section of the subject is acquiring a great literature of its own. It is impossible to refer to all, and equally impossible to make a representative selection. The institution of the teaching of agriculture by the Science and Art Department, and by the agricultural colleges generally, has led to the production of a large number of elementary textbooks, necessary and useful, but by their nature compilations, and ephemeral. The individuality of a writer is now to be found in a special treatise dealing with some branch of the subject, or in a report upon some series of experiments or investigations. A correspondingly great literature has arisen in America, Germany, and France, and has been largely used in translation and quotation in the preparation of English textbooks.

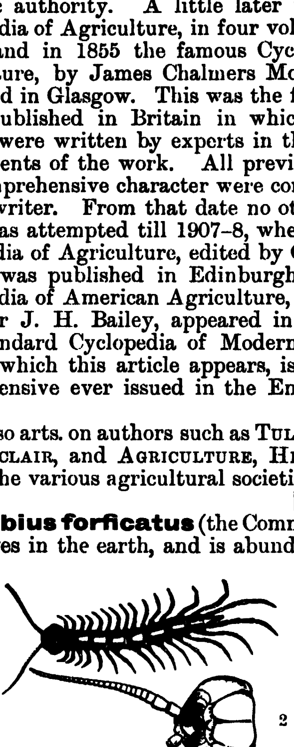
Side by side with the making of many books on agriculture, which commenced on a great scale about the end of the 18th century, there arose a periodical literature, published by individuals or issued as Reports, Proceedings, or Transactions of agricultural societies, and containing great wealth of information. One of the earliest periodicals was the Farmer's Magazine, published in 1776, and still known by that name in 1881. The publications of the Bath and West of England Agricultural Society, which came into existence in 1792; of the Highland, now the Highland and Agricultural, Society of Scotland, and the Quarterly Journal of Agriculture, did much to enlighten agricultural opinion in the early part of last century. The Royal Agricultural Society of England, organized in 1859, has since published an annual, which, along with the Transactions of the Highland and Agricultural Society of Scotland, embodies a whole library of agriculture. With the rise of the agricultural colleges is coincident the printing and circulation of reports on the results of field experiments and laboratory investigations which have proved of much value in building up the science of agriculture, and which are now in many cases issued as annual reports. The present Board of Agriculture in 1893 began the publication of a journal which contains authentic statistics and data, as well as many articles of the first importance. This journal increases yearly in interest and value to the farming community. A similar journal is published by the Department of Agriculture and Technical Instruction in Dublin. The most recent periodical, chiefly important to the teacher and investigator, is the Journal of Agricultural Science, published in Cambridge. To the last-mentioned class, one of the most valuable of all periodicals is the Experiment Station Record, issued monthly by the Department of Agriculture of the United States of America, and containing a summary description of the experiments, and their results, carried out by agricultural colleges and similar institutions in all parts of the world.

An encyclopædia is the corollary of specialism, and so in 1825 there appeared the first of the encyclopædias, the Encyclopædia of Agriculture, by John C. Loudon. The third edition appeared in 1835, remained a standard work of agriculture for many years, and is still valuable. In 1842 Johnson's Farmer's Encyclopædia of Agriculture and Dictionary of Rural Affairs came out, and was followed in 1844 by the first edition of Stephen's Book of the Farm, a well-known work, but almost entirely a practical and technical manual, with little or no pretence to scientific authority. A little later the Rural Cyclopædia of Agriculture, in four volumes, was issued, and in 1855 the famous Cyclopedia of Agriculture, by James Chalmers Morton, was published in Glasgow. This was the first cyclopædia published in Britain in which all the articles were written by experts in the various departments of the work. All previous works of a comprehensive character were compilations by one writer. From that date no other cyclopædia was attempted till 1907-8, when the Encyclopædia of Agriculture, edited by Green and Young, was published in Edinburgh, and the Cyclopædia of American Agriculture, edited by Professor J. H. Bailey, appeared in America. The Standard Cyclopedia of Modern Agriculture, in which this article appears, is the most comprehensive ever issued in the English language.

See also arts. on authors such as TULL, YOUNG, and SINCLAIR, and AGRICULTURE, HISTORY OF, and on the various agricultural societies.

[R. B. G.]

Lithobius forficatus (the Common Centipede) lives in the earth, and is abundant in arable land, but is entirely carnivorous, feeding on insects and earthworms. It is about 1 in. long; smooth, shining, and of an ochre or rusty colour; the two antennæ are long, tapering, and many jointed; the head is large, with a mass of little eyes on each side; the body is flat and furnished with fifteen pairs of legs, the hindermost pair the longest. Behind the head is a pair of poison claws which can inflict a wound which is immediately fatal to insects. See also MYRIAPODA.



Lithobius forficatus (the Common Centipede)

1, The centipede, natural size; 2, under surface of the head, enlarged.

[J. C.]
[C. W.]

Litmus is a blue dye prepared by macerating certain lichens, such as *Roccella tinctoria*, in a mixture of urine with alkalis, viz. potash and lime. The lichen becomes first reddish then

blue, and when dried resembles indigo. Litmus is a delicate test for acids and alkalis, since blue litmus becomes red in presence of an acid; the blue tint is restored in presence of an alkali. Litmus paper for ready detection of acids or alkalis is prepared by soaking bibulous paper in a solution of the litmus dye. Books of paper so prepared are sold by chemical dealers—the blue paper serves for detecting acids, the red for detecting alkalis. *Roccella tinctoria*, from which litmus and orchil are prepared, is a dull-grey lichen frequently found growing on rocks by the sea. From the shield-shaped disk which attaches the plant to the rock there rises into the air the worm-shaped forked body (thallus) from which the dye is manufactured.

[A. N. M'A.]

Litter, the materials used for bedding purposes in the stalls of animals. It is an axiom in the management of stock of all kinds that the degree of success achieved is greatly affected by the measures adopted to ensure the comfort of the animals. The provision of a dry, comfortable bed has, therefore, long been considered essential to the wellbeing of animals fed under cover, and is the purpose which must above all be satisfactorily fulfilled by any materials used as litter, however excellent they may be in other respects. The use of suitable litter is, however, accompanied by many other advantages, not the least of which is its influence upon the size and quality of the manure heap (see FARMYARD MANURE). Thus, not only does it contain in itself valuable fertilizing matter and give rise on rotting to large quantities of humus, but a good litter will absorb great quantities of urine and also the valuable ammonia so rapidly produced from it by fermentation and so easily lost. Further, owing to its bulky and porous nature, and in some cases to the micro-organisms which it supplies, the litter exercises a great and usually very beneficial influence upon the fermentation of the animal excrements, on which the ultimate value of the manure so largely depends. As still further practical advantages accruing from the use of litter, may be cited the greater ease with which the stalls and sheds can be kept in clean condition, and with which also the dung produced by the stock can be uniformly distributed over considerable areas.

Material used as litter should hence be sufficiently soft in texture to ensure the comfort of the animal when lying down; it should have great absorptive power for liquids and for gaseous ammonia, and should itself be capable of slow fermentation with loss of its fibrous structure (*i.e.* formation of humus) and liberation of the fertilizing ingredients contained in it. Generally speaking, any substance which possesses these properties and is obtainable at low cost may be used as litter. A great variety of materials has therefore been used for this purpose in different localities and at different times, but the only materials at all widely employed are *straw*, *peat moss*, *bracken*, *sawdust*, *spent tan*, and *fallen leaves*. It is therefore unnecessary to deal at length with more than these materials. For convenience of future reference, the average percentages of the different manurial ingredients present in them are given in the following table. It must be borne in mind, of course, that the variations in composition (and also in absorptive power) between individual samples of any one kind of litter are very great.

	Nitrogen.	Phosphoric Acid (P_2O_5).	Potash (K_2O).	Lime (CaO).
	per cent.	per cent.	per cent.	per cent.
Wheat straw	0·45	·2	0·8	0·2
Barley straw	0·5	·2	1·1	0·3
Oat straw	0·55	·2	1·5	0·4
Peat moss	0·8	·1	0·1	0·1
Bracken	1·3	·2	0·1	0·5
Sawdust	0·5	·2	0·5	1·0
Spent tan	0·8	?	?	?
Fallen leaves—Beech .	1·0	·25	0·25	2·0
,, ,, Oak .	1·0	·2	0·35	1·7

Straw has been universally employed as litter from the very earliest times, and is still almost the sole form of litter used outside the towns.

It is in many ways admirably suited for the purpose, since not only does it form an ideal bed for the animals, but, owing to its tubular structure and the absorptive nature of its constituents, it has great absorptive powers for liquids and for ammonia. Thus it will absorb and retain under conditions admitting of free drainage often fully three times its weight of urine, whilst if cut into short lengths the absorptive power will be even greater.

The rough chaffing of straw for litter is now practised by many farmers, and is warmly recommended as being economical and giving a manure more concentrated and more convenient to handle and distribute. Little is gained, however, by cutting the straw into pieces less than 6 to 9 in. long, and indeed, where the litter is allowed to accumulate under the animals, a little long straw will always be required to prevent the animals sinking too deeply into the bed.

Of the common straws, wheat straw, being hard and clean, makes the best litter. Oat straw comes next, but is decidedly inferior; and since it is usually a much more valuable foodstuff than wheat straw, ought rarely to be used as litter if other straw is available. Barley straw is not very satisfactory litter, being inferior in durability and cleanliness to wheat straw, whilst the sharp awns are frequently productive of discomfort to the animals.

From the chemical standpoint the chief con-

tributions made by straw litter to the manure heap are its *potash*, its fermentable *humus*, and, to a less extent, its *nitrogen*. Speaking generally, straw grown in the north of England and in Scotland has probably a somewhat higher manurial value than that grown in the south, where more perfect ripening of the grain is commonly effected, and the straw is consequently more thoroughly depleted of its nutrient matters. It will be seen from the table that straw is not very rich in manurial ingredients, 1 ton of wheat straw supplying, as a rule, only about 10 to 12 lb. of nitrogen, 4 to 5 lb. of phosphoric acid, 20 to 25 lb. of potash, and 7 to 10 lb. of lime. It may be noted, however, that this comparative poverty is common to all the different litters, and that, compared with the other materials included in the table, straw is inferior only in its content of nitrogen. Even this inferiority is more apparent than real, since straw decays more rapidly in the soil than the other materials do, and hence places its scantier store of nitrogen more readily at the disposal of the plants than they. In addition to the humus and fertilizing matter which it supplies, straw litter carries myriads of bacteria which greatly affect the fermentation of the manure (see art. FARMYARD MANURE). In this respect it is markedly different from all other forms of litter. The merits of straw for the purposes of litter are so great, and the practical considerations which ordinarily compel its use in this way on the farm so weighty (see FARMYARD MANURE), that it is doubtful whether straw will ever be replaced there to any great extent by any other form of litter. The case is different, however, in town stables and cowsheds, where litter must be mainly purchased, and storage accommodation is frequently very limited. For such conditions straw is rather bulky, and in dry seasons often difficult to obtain or expensive. It is hence there where straw is chiefly replaced by other materials, notably peat moss and sawdust.

Peat moss has long been used as litter in districts where it is found, but its manufacture for general use is of very recent origin, the first satisfactory process of preparing it for the market being that devised and worked in Germany by Hollmann in 1878. The manufacture received a great impetus from the deficiency of straw in the harvest of 1881, but the inferior quality and dampness of much of the material subsequently supplied created a prejudice against the litter from which the trade has only very slowly recovered. The best peat-moss litter is prepared from the yellowish-brown spongy layers of moss peat which are found underlying the natural vegetation of many bogs and overlying the older and darker peat which is used as fuel. The moss is first cut out and then exposed to frost, since after having been frozen it retains better its spongy nature and dries more rapidly. After drying by exposure to air the material is shredded by machinery, the peat dust (peat mull) sifted out, and the moss then strongly compressed into bales. Good samples will contain not more than 20 to 25 per cent of water and about 2 per cent of mineral matter.

The great value of peat-moss litter lies in its great absorptive powers for liquids and gases. In these respects it is far superior to any other litter. Thus good, dry samples commonly absorb from seven to ten times their weight of urine, these proportions being indeed sometimes greatly exceeded. This power, along with its remarkable absorptive properties for ammonia and other strongly-smelling gaseous products of the fermentation of the excrements, enables the peat moss to effect a very high degree of conservation of the animal excrements, and at the same time greatly reduces the contamination of the atmosphere of the stable which is so noticeable in closed or insufficiently ventilated buildings. Its superiority over straw in this latter respect has been strikingly demonstrated in extensive tests carried out in Prussian cavalry stables. It was found that the horses littered with peat moss (about 5 lb. per horse daily) suffered far less from catarrh of the nose and eyes and other complaints arising generally from a tainted atmosphere, rotting of the frog was almost entirely prevented, and cases of colic were far less frequent than amongst the horses littered with straw.

It is indeed with horses that the best results have been obtained where the two forms of litter have been compared. Peat moss has not, on the whole, proved quite as satisfactory with cattle and pigs, possibly owing to the relatively much greater volume of urine voided by these animals. This, being so largely retained by the peat moss, will give the bed a rather damp character unless very frequently renewed, and the feet of the animals may then suffer. For cattle that are tied up, the best plan undoubtedly is to use peat moss only on that part of the stand on which the excrements fall, and in the gutter into which the urine drains.

Unlike straw, peat moss carries comparatively few micro-organisms—indeed its tendency is rather to check fermentation than to promote it. Hence manure made with peat-moss litter rots more slowly, and suffers less waste in storage than straw-made manure.

It will be observed that peat moss is much richer in nitrogen than straw, but poorer in mineral ingredients. The greater amount of urine which it conveys to the manure heap more than compensates, however, for this inferiority so far as the potash is concerned, and also adds greatly to the store of soluble nitrogenous matter.

Peat-moss dung is consequently as a rule more concentrated with respect to these ingredients than dung made under comparable conditions using straw. The following analyses by Dyer (1889) bring this out very clearly:—

	Peat-moss Dung (average of 2 samples).	Straw Dung (average of 3 samples).
	per cent.	per cent.
Total nitrogen	·88	·61
(Nitrogen present in form of ammonia or nitrates)	(·51)	(·19)
Phosphoric acid (P_2O_5) ...	·37	·43
Potash (K_2O)	1·02	·59
Lime (CaO)	·33	·70

The value of peat-moss manure obviously de-

pends largely upon the amount of urine absorbed, which will of course be largely determined by the length of time that the litter has remained under the animals. Manure made with peat moss, owing to the much smaller amount of litter used, is much less bulky than fresh straw manure, and is hence better suited for light than for heavy soils. On the latter, indeed, straw dung has a value possessed by no other manure. It should be noted further that the peat-moss residues decay much more slowly than those from the straw manure, and are consequently the less valuable.

Peat, though inferior to peat moss, has considerable absorptive power, and is frequently used for litter where available.

Dried bracken-fern is a popular litter in districts where a plentiful supply is obtainable, and has long been used for this purpose. It is said to suit the animals, though not quite so well as straw.

It has a greater power of absorbing liquids and ammonia than an equal weight of straw, the fine leafy portions being particularly effective. It is moreover much richer in nitrogen than straw, but poorer in potash, whilst the phosphate content is much the same in both. The greater richness in nitrogen is, however, largely neutralized by the fact that the bracken —especially the fibrous woody stems—decomposes much more slowly than straw in the soil, and hence the nitrogen is liberated only very slowly for the use of the plants. Owing to this slowness of action and its bulky character, manure made with bracken is better suited for heavy than for light soils.

Sawdust is used to a considerable extent as litter for horses in town stables. It has good absorptive powers for liquids—retaining often more than four times its weight of urine—but is of low manurial value, and decomposes very slowly in the soil, especially if made from very resinous wood (*e.g.* pitch-pine). In the fresh condition it has occasionally been found to exercise a detrimental influence on crop yields, especially in dry periods. This may also be partly due perhaps to the turpentine and resinous matters which are present in considerable quantities in many kinds of wood. Sawdust tends to render horse manure too open in character, the vigorous fermentation and oxidation thus produced leading to excessive heating ('fire-fang') and unduly great waste of valuable humus and ammonia.

Spent tan is frequently employed as litter in the neighbourhood of tanneries. It is roughly equal to sawdust in absorptive power and manurial value.

Fallen leaves are only rarely used as litter, and are very inferior material for the purpose. They have not a very high absorptive power for liquids, and give a very compact, slowly decomposing humus of sour character. Such manure will be greatly improved by composting with earth. [C. C.]

Livarot Cheese.—This variety of French cheese is chiefly made in the department of Calvados, and is very largely sold to the working classes, owing to its cheapness, for it is usually made of milk which has been skimmed. It is a summer cheese of somewhat strong flavour, but when made from full milk it is not only richer, but more delicate on the palate, and costs 10*d.* to 1*s.* per lb. It has been estimated by a French expert that the annual value of the milk of a Norman cow, where the cream is converted into butter and the skim milk into Livarot, amounts to from £14 to £16 net. Where the milk is skimmed it is heated to a temperature of 86° to 100° F., according to the system of the maker; the rennet, however, is usually added at 95° F., the milk being placed in vessels holding from 40 to 50 gal. Coagulation takes place at the end of ninety minutes or thereabouts, when the curd is cut and gently broken until the removal of the whey leaves it firm enough to place upon mats which are made of rushes, or upon a cloth the corners of which are suspended, and here it remains for a quarter of an hour. After sufficient drainage the curd is broken into particles slightly larger than a grain of rice, when it is placed in the moulds, which are circular in form, about 5 in. both in diameter and height. At the end of about an hour the moulds are turned, turning being continued several times until, drainage having given firmness to the curd, it is ready for salting. The cheese is then placed upon an inclined shelf for a few days for more perfect drainage and drying. In the drying room the cheese remains from three to four weeks, when it is taken to the ripening room, an apartment from which the air is largely excluded, this exclusion assisting in the production of the flavour for which it is renowned. While in the ripening room the cheeses are turned three times weekly during the summer months, or twice when made in winter, being gently washed each time of turning with water which has been slightly salted if salt is still required; if, however, salting has been sufficient in the first instance, pure water is used alone. The object of the washing process is to hinder the development of fungi on the crust. The process of maturation is not completed until from three to four months, or longer if the cheese is large. This variety of soft cheese is well worthy of attention in this country, inasmuch as it supplies a want which the buttermaker needs, as it would pay him better than supplying his skim milk to his swine. [J. Lo.]

Liver, Diseases of.—Animals leading a natural life escape most of the diseases of the liver from which their masters suffer, but are more subject to such as have their origin in parasitism—tapeworm cysts, and flukes, for example. The dog, from his artificial habits, is most frequently a victim to liver disorders, but in common with the other domesticated animals responds quickly to treatment if the disturbance is merely functional, and not due to tuberculosis or degeneration of the hepatic cells. The horse comes next in frequency, as often living in confinement and receiving too highly nitrogenous a ration, that he may be able to labour. The symptoms common to liver disorders, whether arising from specific diseases such as influenza, glanders, or those already

referred to, are dullness, loss of spirits, inappetence, a pasty appearance of the tongue, sour-smelling breath, and staining of the visible membranes a yellowish colour. The latter symptom is particularly observed in jaundice, or the 'yellows', in all species. In dogs, the discoloration extends to the pads of the feet and hairless portions of the body. Obstructions of the portal circulation induce 'yellows' without previous apparent liver symptoms, and the pathology of the malady is not clear. Congestion or inflammation of the liver is accompanied by increased temperature, unusual tenderness on the right side, sometimes lameness of the off fore leg; constipation, the fæces being small, hard, covered with mucus and glazed, and this condition may be changed to scour or diarrhœa when the absence of bile in the intestine permits of fermentation of the ingesta, and air bubbles are seen in the fresh droppings of cattle. The stabled and corn-fed horse, the fattening ox, and the pet dog need depletive treatment, as bleeding and purging, and a reduced ration. Horses and cattle profit by a dose of calomel and aloes, followed by salines as Epsom salts, sulphate of sodium, bicarbonate of potash, and acetate of potash (see Medicines, Doses of), and a return to natural conditions of life. Town horses, and cows long tied up and forced for milk production, respond to a turn out at grass, and there is reason to suppose that when actual degeneration (cirrhosis) has begun, it is often arrested, and the patient so far restored as to live in health, with the portion of functionally active liver remaining.

[H. L.]

Liver Fluke in Sheep.—Liver fluke (*Distomum hepaticum*) is the well-known, almost cosmopolitan, endoparasitic Trematode that lives as an adult in the bile ducts of the sheep and causes the serious disease called liver rot. Unlike most flukes it occurs in many hosts, having been reported, for instance, from horse, cattle, goats, deer, antelopes, camel, pig, beaver, squirrel, kangaroo, and man himself, but its chief host is the sheep. Its larval stages occur (as far as Europe is concerned) in a small fresh-water snail, *Limnæa truncatula*, which is widely distributed in ponds and streams, spreading into the low-lying meadows in times of flood. In countries beyond Europe other amphibious snails also serve as hosts. In the Sandwich Islands the intermediate host is said to be *Limnæa peregra*, but this species does not seem to serve as a *successful* host in Britain. In Victoria the host is said to be *Bulimus tenuistriatus*. In a liver-fluke epidemic among horses and cattle in the Hawaiian Islands, the intermediate host of the fluke was yet another species, *L. Oahuensis*. A large species of liver fluke, *D. magnum*, first known as a parasite of deer in Italy, has become a serious parasite of sheep in the western plains of the United States.

The liver fluke is flat, oval, and leaflike, almost 1 in. in length by ½ in. across the broadest part, reddish-brown to greyish-yellow in colour. As the name Distomum suggests, there are two suckers—an anterior, perforated by the mouth; a second, imperforate, a little farther back on the mid-ventral line. The fluke has an intricate internal structure, but it is not necessary here to do more than call attention to the fact that it has a very much branched food canal with no opening but the mouth, and a complex hermaphrodite reproductive system. It should be noted that the fluke sucks blood—not bile—from its host.

The liver fluke is able to fertilize its own eggs, and the developing eggs pass in large numbers from the bile duct of the sheep to the intestine and thence to the exterior. A single fluke may produce about half a million embryos, which illustrates the prolific reproduction often associated with the luxurious conditions of parasitism, and almost essential to the continuance of species whose life-cycles are full of risks. Outside of its host, but still within the egg case, the embryo develops for a few weeks, and eventually escapes at one end of the shell. Those that are not deposited in or beside pools of water must die. The free embryo is microscopic, conical in form, provided with two eye spots, covered with cilia, and actively locomotor. It swims about for some hours, but its sole chance of life depends on meeting the water snail already mentioned. It bores its way into the respiratory chamber of the snail, loses its cilia, begins to grow, and becomes a sporocyst. Within the sporocyst certain cells behave like parthenogenetic ova and develop into rediæ, or 'King's yellow worms' as they used to be called.

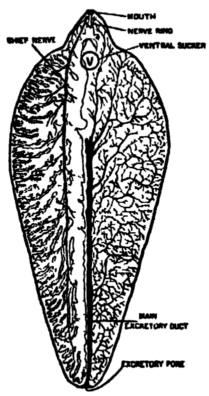


Diagram of Liver Fluke
(*Distomum hepaticum*)

The rediæ represent a second larval stage. They are cylindrical, and have a short food canal. Within the rediæ more rediæ develop, and finally yet another larval stage—the cercariæ—which are quite different from rediæ, and are, in fact, the young flukes. They have long tails, two suckers, and a forked food canal. They make their way out of the dead or dying water snail, they swim about in the water and eventually wriggle up stems of damp grass. There they encyst, losing their tails in the process. They appear as minute white spots on the grass. If a cercaria be eaten by a sheep it grows in about six weeks into a fully formed and sexual fluke.

It will be noted that there is here a good illustration of what is meant by *alternation of generations*. There are at least two and often more asexual generations interpolated between the embryo and the adult. Another point of interest is that the chances are enormously against the embryo becoming an adult—it may be deposited on dry ground, it may reach a pool without a water snail, it may fail to find the water snail in time, the water snail may be eaten by a fish, the cercaria on the grass may

be dried up by the sun, the grass may not be eaten by a sheep, and so on. Yet the race of liver flukes continues.

As one would infer from the life-history, wet years favour liver rot, the disease reaching its height in the succeeding winter. In 1879–80 three millions of sheep are said to have died of rot in England; the annual loss in the United Kingdom was formerly estimated at a million animals, but this number has been much reduced by drainage, &c. [J. A. T.]

SYMPTOMS.—The symptoms exhibited by infected sheep in this disease may with advantage be classified as to their exhibition under three periods or stages, viz.: *First stage*, or invasion.—As a rule, sheep in good condition whose bodies have been invaded by the fully developed fluke parasite present no outward evidences of being infected until the months of October, November, or December; but if invasion has taken place it is now observed that they are dull, disinclined to roam about, apparently weak on their limbs, and if caught and examined they are found to have lost flesh. In certain districts it is remarked that in this stage the tendency is for the sheep to eat greedily and put on condition, and at this period they are consigned to the butcher. Sheep in this stage are frequently exposed and sold in store and fat markets, and with little loss if slaughtered; but if they are purchased by an unexperienced person for store or feeding purposes, as is sometimes the case, then the direct loss is considerable, and besides a sound pasture land may in this way become infected.

Second Stage.—The second stage of distomatosis is characterized by an aggravation of all the symptoms exhibited in the first stage, and in addition we may have paleness of all the visible mucous membranes, harshness and dryness of the wool, and its removal if subjected to the slightest tension by the hand. In this stage, if the fæces be subjected to a microscopical examination the eggs of the fluke will be found present, or if a post-mortem is made the flukes with their eggs will be found in either the bile ducts or substance of the liver.

Third stage, or that of marked wasting, generally sets in about the end of January; and notwithstanding that a generous diet is being provided, and that some of the members of the flock are feeding fairly well, all that are affected to any great extent are daily becoming thinner and weaker, and by the end of February the bulk of them have died from anæmia, dropsy, diarrhœa, &c.

TREATMENT.—The treatment of this disease is best embraced under two heads, viz.: (1) Preventive, and (2) Curative.

1. *Preventive.*—From the history given, it is self-evident that preventive is better than curative treatment. If the pasture land is well drained, distomatosis or liver-fluke disease cannot prevail, unless sheep are introduced in whose livers the adult fluke parasites are present. A field, however, may be fairly well drained and yet lend itself to the propagation of the disease if 'sitfasts' are in it from underground workings, and a running stream occasionally overflows its course, leaving pools of water and snails in the 'sitfasts'. Some of the worst outbreaks of distomatosis have been traceable to these conditions, and especially in pregnant ewes on bare pasture lands, although receiving bountiful supplies of grain, hay, and roots.

By drying the pasture lands and getting rid of the stagnant water, we get rid of the snails to a certain extent, and those present are deprived of the power of complete development by the dryness of the soil and the absence of moisture. It is all-important for the flockmaster to remember that the fluke parasite perishes unless it gains an entrance into the body of the snail, and thereafter gains an entrance into the body of the sheep.

2. *Curative.*—This, as a rule, is never satisfactory unless the flukes present in the liver be few in number, because the medicinal agents administered which in potency would poison the flukes located in the liver would kill the sheep.

A marked feature in this malady is the poor, watery condition of the blood, and the want of power to form a sufficiency of healthy red corpuscles. Preparations of iron in the form of saccharated carbonate and the sulphate may be given with crushed oats and linseed cake.

A free supply of rock salt in the feeding troughs should be allowed, and undoubtedly topdressing the land with salt and lime will destroy both eggs and parasites; but a cheap and more effectual topdressing as a destructive agent to the snails and parasites is fresh gas lime, and it invariably sweetens the pasture and increases its feeding properties. [J. M'C.]

Liver of Sulphur is the name of the brownish solid obtained by heating sulphur and potassium carbonate in closed vessels. It is a mixture of several sulphides of potassium with some of the sulphate and carbonate. Being an effective insecticide, it often forms one of the components of sheep dips. A solution containing about 4 per cent of the solid is used for that purpose. It is poisonous to the roots of plants and corrosive to foliage. [R. A. B.]

Liver Rot in Poultry is a parasitic disease in poultry caused by a minute protozoon (*Amœba meleagridis*). For a description of the disease and preventive measures to be adopted, see AMŒBA MELEAGRIDIS.

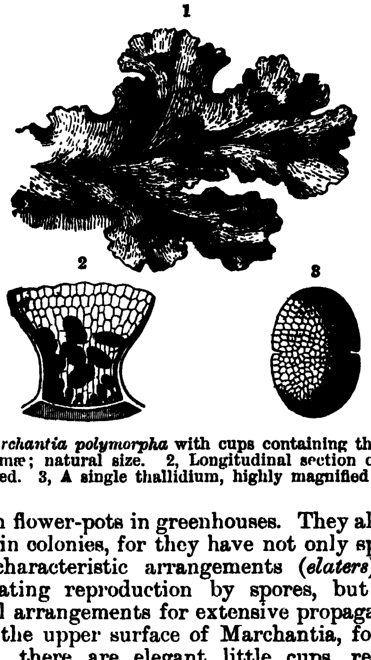
Liver Rot in Rabbits, a disease caused by a microscopic protozoon. See COCCIDIUM OVIFORME.

Liverwort is the common name for a whole class of flowerless plants very closely allied to the mosses and called by botanists *Hepaticæ*. The ancients regarded certain of these plants as curative agents for liver complaints, hence the name. Some liverworts closely resemble lichens, but microscopic examination shows that the resemblance is merely superficial: the structure of the body of the plant is quite different from that of the lichen, and quite different also are the sexual organs (*archegonia* and *antheridia*) engaged in the reproductive process.

In some cases, for example Marchantia, there is no stem, nor leaf, nor root: the body of the

plant is of very simple construction, merely a horizontal, flat expansion of green cells (*thallus*) with a multitude of hairs (*rhizoids*) on the lower surface for the special purpose of absorbing the necessary water and minerals from the substratum. On the upper surface of the green body there are numerous pores, arranged with such regularity that the atmospheric air required for breathing and for the manufacture of sugar can readily enter and leave every part of the structure. In other cases, for example Jungermannia, the body of the plant has a more complex construction, and now, like the moss, is composed of a leafy stem with hairs as before, but not roots, for absorbing from the substratum.

Liverworts are extremely common on waste damp ground, on damp walls, in shady places,



1, *Marchantia polymorpha* with cups containing thallidia or gemmæ; natural size. 2, Longitudinal section of cup, magnified. 3, A single thallidium, highly magnified

and on flower-pots in greenhouses. They always occur in colonies, for they have not only special and characteristic arrangements (*elaters*) for facilitating reproduction by spores, but also special arrangements for extensive propagation.

On the upper surface of Marchantia, for example, there are elegant little cups, readily noticed by the naked eye, full of miniature plants (*gemmæ*) which easily detach, and soon colonize a whole area of suitable land with the liverwort. These *gemmæ* play the same part as the tubers of the potato, or the runners of the strawberry. [A. N. M'A.]

Live Stock.—This is a general term used to designate those domesticated animals which form part of the equipment of every farm. Horses, cattle, sheep, pigs, poultry, goats, dogs, and in fact all forms of animal life which are usually associated with agricultural practice and which command a marketable value, are included in this designation. DEAD STOCK, on the other hand, denotes implements of tillage, agricultural machinery, the stored produce of the farm, and those other requisites which are associated with the science and practice of agriculture. For a description of the various breeds of live stock, the reader should consult the special articles on horses, cattle, sheep, pigs, &c.

Live Weight.—The actual weight of an animal when in life is spoken of as the live weight. The methods of ascertaining the live weight of cattle by measurement are described in the art. MEASUREMENT OF CATTLE, while the relation of live weight to dead weight or carcass weight is given in the art. CARCASS.

Lizards (Lacertilia), an order of Reptiles, including a large number of distinct types, most of which have well-developed limbs, movable eyelids, and a covering of cutaneous scales. The majority are terrestrial, a few are semi-aquatic; most of them are active, swiftly moving animals, some live as burrowers underground; most are carnivorous, but not a few are vegetarian. The carnivorous forms have some agricultural importance as destroyers of insects and insect larvæ, slugs, worms. The Eyed Lizard (*Lacerta ocellatus*) of southern Europe, which may reach a length of 2 ft., will eat mice, small snakes, and other lizards. The large 'Tejus' (Tupinambis) of South America, which may be a yard long, sometimes take chickens and eggs from the farms. Severe symptoms in man have been reported as the result of the bite of the North American poisonous lizard (Heloderma), but this is the only case. There are three British lizards: (1) the widespread Common Lizard (*Lacerta vivipara*), a shy, harmless creature, feeding on insects, snails, and worms; (2) the Sand Lizard (*Lacerta agilis*), restricted to the south of England; and (3) the limbless Slow Worm (*Anguis fragilis*), not uncommon in some of the wilder parts of Britain, a timid, harmless animal feeding on earthworms, slugs, insects, and spiders. It is wanton mischief to destroy any of these three British lizards. [J. A. T.]

Llama.—Broadly speaking, the term Llama embraces the two wild species and the two domesticated races of hornless ruminating animals, allied to the camels, which occur in South America. The essential differences between these four types, known as the Guanaco or Huanaco, the Vicuña, the Llama, and the Alpaca, have already been briefly discussed in an earlier part of this work under the heading ALPACA. On the present occasion, therefore, it need only be repeated that the variety to which the name Llama is strictly applicable is the larger of the two domestic races, the race which is admitted by all to be a domesticated descendant of the wild Huanaco (*Lama huanachus*).

Although the date of the domestication of llamas has not been ascertained, but was conjecturally coeval with the original occupation of the Andean region of South America by the Indian tribes which made their way into the country from Mexico, these animals were first made known to Europeans by the Spanish conquerors of Peru, who not unnaturally mistook them for a large and peculiar kind of sheep, a species to which, with their thick and long woolly coats, they bear no little resemblance. Since horses, asses, and sheep were before that date quite unknown to the aborigines, the Llama was used not only as a beast of burden but also to supply meat and wool. The wool, however, is of a much coarser quality and of a much less service-

Photo. W S Berridge

LLAMA

Photo. W S Berridge

MARKHOR (*Capra falconeri*)

WITH GIMLET SHAPED HORNS

able kind than that of the Alpaca, and the flesh as an article of diet is much less palatable than that of sheep. Moreover as beasts of burden llamas have proved, by inferiority in strength and characteristic defects in temperament, to be far below the standard of asses and mules, with the result that during the past three hundred years or so they have been gradually superseded by the above-mentioned domestic animals that have been introduced into the country from Europe. It does not appear that they were ever used to any extent for purposes of riding, although capable of carrying a weight of about 100 lb. fifteen or twenty miles a day. Their mode of progression is a steady walk, in single file, led by an old male; but if at all overweighted they have the habit of lying down upon the ground and resisting all efforts to make them move. They were formerly largely used for carrying ore in the mining areas of Peru; and for work in mountainous districts they are in some respects superior to mules and asses, their lightness of build, their padded, cleft, and nail-tipped feet enabling them to traverse and secure a foothold in precipitous places, over which mules and asses are unable to pass. Like camels, too, they are able to go a long time without drinking, and, it has been said, require no water when green food is available. Llamas stand about 4 ft. high at the shoulder, and are occasionally black, brown, or white in colour, but more commonly a mixture in varying degrees of black and white or brown and white. The period of gestation is said to be six months, and only one young one is produced at a birth. [R. I. P.]

Load, a measure which varies in different localities with different classes of goods, but which nevertheless has a definite value or equivalent for each particular type or class of material. The various equivalents of the load are:—

Bricks	500
Coals (Scotch)	1 ton.
Flour	2 bolls or 280 lb.
Gravel or earth	1 cu. yd.
Lime	32 bus.
Hay (old)	18 cwt.
,, (new)	19 cwt. 32 lb.
Straw	11 cwt. 64 lb.
Timber (round)	50 cu. ft.
,, (squared)	40 cu. ft.
Wheat (imperial)	5 qr.
,, (market)	5 bus.
,, (Manchester) ...	4·8472 qr.

Loams.—No exact definition of a loam can be given; it can only be said that loams form an intermediate series between sands and clays. They therefore show a considerable amount of diversity in physical structure although they have certain features in common. The bulk of the soil is made up of fine sand and silt, *i.e.* of particles ranging from ·2 mm. ($\frac{1}{125}$ in.) to ·01 mm. ($\frac{1}{2500}$ in.) in diameter. The coarser particles (coarse sand) show considerable variation in amount, ranging from about 25 per cent downwards to less than 1 per cent, but it is frequently less than 10 per cent. The finer particles also vary considerably; the fine silt from ·6 to 15 per cent, and the clay from about 9 per cent in a light loam to about 18 per cent in a heavy loam; it is impossible, however, to assign definite limits because loams shade off insensibly into clays on the one side and sands on the other. The mechanical analyses of a few typical loams are given below:—

Mechanical Analyses of Loams

Constituent Substances.	Geological Formation. Locality					
	1. Bagshot Sand on London Clay, Claygate, Surrey.	2. Lower Greensand, Loddington, Kent.	3. Thanet Beds, Selling, Kent.	4. Upper Greensand, Buckland, Surrey.	5. Brick Earth, Wye, Kent.	6. Brick Earth, Merston, Sussex.
Gravel (above 1 mm.) ...	·73	3·56	·66	1·00	1·04	·97
Coarse sand (1 to 0·2 mm.) .	24·87	10·26	4·76	3·45	3·07	1·35
Fine sand (0·2 to 0·04 mm.)	38·65	33·50	55·23	43·95	27·26	16·03
Silt (0·04 to 0·01 mm.) ...	11·28	14·67	14·14	20·00	40·07	35·50
Fine silt (0·01 to 0·002 mm.)	6·02	14·95	5·71	14·14	8·93	13·39
Clay (below ·002 mm.) ...	9·90	12·23	10·96	10·18	11·25	15·91

The capacity for being easily worked, and the moderate retentiveness of loams, is to be assigned to the 9 to 18 per cent of clay present; these figures become more intelligible when it is remembered that soils containing less than 4 per cent of clay are generally too light for profitable cultivation, whilst soils with more than 25 per cent of clay are, as a rule, too heavy, and can only be laid down to grass.

The water supply is usually very satisfactory. The fine sand and silt, which together make up 50 per cent or more of loam, possess to a greater degree than any other fraction the power of lifting water from the depths of the subsoil to the surface. At the same time these fractions permit any excess of water to drain away. Thus they bring about a fairly rapid and even distribution of water throughout the soil and subsoil, the subsoil either taking off the excess from the surface or else supplying water to the surface, and the movement of the water is not impeded as it would be if a large amount (20 per cent or more) of clay were present. It is for this reason that loams, especially deep loams, suffer less than most soils in time of drought; light sands suffer first, then clays, but loams can generally supply water to the crop even during a long spell of dry weather. Soils 4, 5,

and 6 are particularly good in this respect; the two latter indeed have never been known to dry out.

Although loams are easily worked they must not be touched when too wet, or they become sticky and cake badly on the surface; particularly is this the case when only a little coarse sand is present, as in soils 4, 5, and 6. In consequence of the larger amount of clay and fine silt, loams are not as 'early' as sands. Crops do not mature as readily as on a sandy soil, but continue growing later in the season; they are, however, not unduly late, and generally they finish well.

In chemical composition, as in mechanical composition, these soils are intermediate between sands and clays. Alumina varies from 3 to 5 per cent, being usually about one-third of the clay; ferric oxide ranges from 2 to 3 per cent. The calcium carbonate shows considerable variation, depending partly on the soil and partly on its manurial history; the high amounts in 3 is due to heavy chalking. Potash varies with the formation from ·2 per cent in the light sandy loam to about 1 per cent in the heavier loams. The large amount of 'available' phosphoric acid, which is mainly due to manuring, shows how intensely these soils are cultivated. Yet such is their open texture, and so active are the decomposition processes in the soil, that the amount of organic matter is not high, being usually about 5 per cent, and the nitrogen is rarely above ·22 per cent, usually it is only about ·15 per cent.

Chemical Analyses of Loams

Constituents of Loam.	Geological Formation. Locality.					
	1. Bagshot Sand on London Clay, Claygate, Surrey	2. Lower Greensand, Loddington, Kent.	3. Thanet Beds, Selling, Kent.	4. Upper Greensand, Buckland, Surrey.	5. Brick Earth, Wye, Kent.	6 Brick Earth, Merston, Sussex.
Moisture	2·39	3·46	1·91	3·34	1·76	3·32
Organic matter (*i.e.* loss on ignition)	3·41	4·65	3·49	4·51	5·56	6·58
Nitrogen	·114	·141	·136	·184	·226	·220
Alumina	2·79	2·69	3·49	5·5	3·83	5·50
Ferric oxide	2·18	3·78	2·75	2·16	2·70	3·05
Manganese oxide	nil	·06	·05	·07	nil	·06
Magnesia	·28	·41	·85	·28	·26	·40
Lime	·28	1·02	1·54	1·29	·42	1·79
Carbonates (expressed as calcium carbonate) ...	nil	·36	3·66	·40	·18	·75
Potash	·230	·738	·573	·975	·376	·431
'Available' potash	·009	·048	·005	·009	·040	·014
Phosphoric acid	·065	·143	·127	·112	·251	·138
'Available' phosphoric acid	·013	·066	·043	·05	·119	·020
Sulphuric acid	·03	—	·03	·05	·07	·06

Manuring of Loams.—Loams are not characteristically deficient in any plant food, and the scheme of manuring is regulated mainly by the climatic conditions and the special requirements of the crop. Calcium carbonate is present in variable amounts, and not infrequently has to be added; either lime or chalk can be used. When the amount of coarse sand is quite small it may happen that nitrate of soda causes the soil to work unkindly by deflocculating the clay; in such cases dung or organic manures like fish or meat meals are better sources of nitrogen, and the new nitrate of lime may be expected to be very useful. It has already been stated that plants naturally continue growing late into the autumn, consequently potash, which tends to prolong the life of the plant, is not usually necessary except in dry districts or for special crops like potatoes and mangolds; for potatoes sulphate of potash is the better, and for mangolds kainit is more suitable. Potash is also likely to increase the yield of peas, but its use would not necessarily be profitable for market-garden purposes, since the peas would probably be kept back a little. Phosphates are generally more useful, especially where the soil is kept in good condition by the liberal use of good dung and other manures, since they promote the ripening processes and so tend to finish the crop well. The higher the rainfall the more useful phosphates are likely to be. Swedes and turnips will nearly always be found to respond to large dressings of phosphates, even though there may be large quantities of available phosphoric acid in the soil, provided there is sufficient rainfall and not too high a temperature. Similarly hops almost invariably respond, as also do potatoes. Phosphates also cause wheat to ripen more readily, and should therefore always be used where there is any risk of bad weather interfering with harvests. Considerations of climate usually determine what form the phosphates should take: in dry districts, as in East Kent, superphosphate is the most useful; in wet districts basic slag may be almost as good, and distinctly cheaper; where the conditions are unfavourable for basic slag, one of the bone phosphates may be used, *e.g.* steamed bone flour.

Crops Suitable for Loams.—Loams will grow almost any crop, provided there is sufficient depth of soil; indeed so well are they adapted to cultivation that they have escaped to a large extent the change from arable to

grass land that has been so noticeable a feature of British agriculture in the last few decades. The brick earths and loamy Thanet of Kent produce hops, all kinds of fruit, especially cherries, large crops of wheat, peas, &c.; the famous maritime region of Sussex gives heavy yields of wheat, oats, and roots; elsewhere potatoes do well. In general, loams are too strong to produce good-quality barley, and not strong enough for beans, though exceptions are by no means uncommon; they are also not usually forward enough for market-garden produce, at any rate for the early markets, and cannot produce certain crops like carrots as well as the lighter soils do. They are less useful than sandy soils for raising nursery stock, since the conditions obtaining are not so favourable for quick development of copious fibrous roots.

WEEDS.—Since loams are an intermediate class of soil they do not possess a special and characteristic flora like chalky or sandy soils, nevertheless certain weeds are very commonly found on fertile cultivated loams—*e.g.* Groundsel, Chickweed, Stinking Mayweed (*Anthemis Cotula*), Sowthistle (*Sonchus oleraceus*), Fat Hen (*Chenopodium album*), Scarlet Pimpernel (*Anagallis arvensis*), Poppy, certain Spurges, Henbit (*Lamium amplexicaule*), Wireweed or Knot-grass (*Polygonum aviculare*). [E. J. R.]

Loans, Agricultural.—Under various Acts of Parliament loans may be obtained on favourable terms for the improvement of land by drainage and in other respects. Under certain Acts called the Public Money Drainage Acts (9 & 10 Vic. c. 101; 10 & 11 Vic. c. 11; 11 & 12 Vic. c. 119; 13 & 14 Vic. c. 31; 19 & 20 Vic. c. 9) any owner of land (including a tenant for life) may obtain advances from the public funds for works of drainage, to be executed upon a certificate of the Board of Agriculture and Fisheries. Such advances are obtained by application to the Board, who, if after investigation they think an advance expedient, may issue a provisional certificate declaring that upon the proposed works having been executed in a substantial and durable manner the Board will cause an advance to be issued, not exceeding the amount of the whole or of such proportional part, as in the provisional certificate shall be expressed, of the expenses actually incurred in the drainage, but limited not to exceed a certain sum in the provisional certificate expressed. The expenses of investigation may also be charged upon the land if the Board think fit. When satisfied of the execution of the works the Board may issue a certificate for an advance under the Acts. The works must be executed within five years of the provisional certificate. The advance to any one owner is limited to £5000, and the amount is repayable by a rent charge of £6, 10*s*. for twenty-two years for every £100 advanced. The rent charge may be redeemed at any time before the expiration of twenty years, with a discount of £3, 10*s*. per cent per annum in respect of future payments. The Improvement of Land Act, 1864 (27 & 28 Vic. c. 114), includes the following 'improvements', viz.: (1) The drainage of land, and the straightening, widening, deepening, or otherwise improving the drains, streams, and watercourses of any land; (2) the irrigation and warping of land; (3) the embanking and weiring of land from the sea or tidal waters, or from lakes, rivers, or streams in a permanent manner; (4) the enclosing of land, and the straightening of fences and redivision of fields; (5) the reclamation of land, including all operations necessary thereto; (6) the making of permanent farm roads and permanent tramways and railways and navigable canals for all purposes connected with the improvement of the estate; (7) the clearing of land; (8) the erection of labourers' cottages, farmhouses, and other buildings for farm purposes, and the improvement of and addition to labourers' cottages, farmhouses, and other buildings for farm purposes already erected, so as such improvements or additions be of a permanent nature; (9) planting for shelter; (10) the constructing or erecting of any enginehouses, waterwheels, saw and other mills, kilns, shafts, wells, ponds, tanks, reservoirs, dams, leads, pipes, conduits, watercourses, bridges, weirs, sluices, floodgates, or hatches which will increase the value of any lands for agricultural purposes; (11) the construction or improvement of jetties or landing places on the seacoast, or on the banks of navigable rivers or lakes, for the transport of cattle, sheep, and other agricultural stock and produce, and of lime, manure, and other articles and things for agricultural purposes; provided that the Board shall be satisfied that such works will add to the permanent value of the lands to be charged to an extent equal to the expense thereof; and (12) the execution of all such works as in the judgment of the Board may be necessary for carrying into effect any matter hereinbefore mentioned, or for deriving the full benefit thereof. By the Public Health Act, 1875, sect. 31, works for the supply of sewage for agricultural purposes, and by 40 & 41 Vic. c. 31, reservoirs, &c., are added to this list. The Act of 1864 also generally facilitates the borrowing of money from land-improvement companies and others for the purpose of any of the above improvements. A landowner, which term includes the person in the actual possession or receipt of the rents and profits of any land, desirous of borrowing money under this Act must apply for the sanction of the proposed improvements to the Board of Agriculture and Fisheries, who may cause the application to be investigated; and if they find that the proposed improvements would effect a permanent increase in the yearly value of the lands proposed to be improved or any part thereof, may sanction the improvement by a provisional order, and may create in favour of the landowner the title to an absolute charge on the completion of the sanctioned improvements, which will enable the landowner to raise money by assigning the same to any person or company. When the Board are satisfied that the improvements sanctioned by them have been properly executed, they will create the charge by an absolute order upon the inheritance of the land for the sum expressed to be chargeable in respect of the improvements, including the expenses of the application, &c.

The charge created by the absolute order will be by way of rent charge, payable by equal instalments half-yearly, extending over a term of years, and the payment for each half-year will be as to part thereof a repayment of a certain amount of principal money and as to the remainder thereof a payment of interest. The term is under the Improvement of Land Act, 1899 (62 & 63 Vic. c. 46), extended to such a period not exceeding forty years, as the Board of Agriculture and Fisheries, having regard in each case to the character and probable duration of the improvement, determine. The grantee of the charge will have priority over every then existing and future charge and incumbrance affecting the land. Under the Limited Owners' Residences Acts, 1870 and 1871 (33 & 34 Vic. c. 56, and 34 & 35 Vic. c. 84), the erection of a mansionhouse and improvements and additions to a mansionhouse are constituted improvements within the meaning of the Improvement of Land Act, 1864, but the sum charged on any estate under settlement in respect of a mansion must not exceed two years' rental of the estate.

Certain companies, such as the General Land Drainage and Improvement Company and the Lands Improvement Company, have by private Acts of Parliament similar powers of advancing money for the improvement of land and taking a charge for repayment of the money advanced, subject to the sanction of the Board of Agriculture and Fisheries, as are given generally by the Land Improvement Acts, and such companies may exercise the powers of the general Act on conforming to its procedure. Charges created under any of the above-mentioned Acts must be registered under the Land Charges Registration and Searches Act, 1888 (51 & 52 Vic. c. 51), at the office of Land Registry, or otherwise they will be void as against a purchaser for value of the land charged therewith. Under sect. 19 of the Small Holdings and Allotments Act, 1908 (8 Edw. VII, c. 36), a county council may, if they think fit, advance to a tenant of a small holding (*i.e.* an agricultural holding which exceeds one acre and either does not exceed fifty, or if exceeding fifty acres is of an annual value for purposes of income tax not exceeding £50), who has agreed with his landlord for the purchase of the holding, on the security of the holding, an amount not exceeding four-fifths of the purchase money. [A. J. S.]

Lobelia, a genus of Campanulaceæ comprising about 200 species of hardy or greenhouse annual and perennial herbs and sub-shrubs, mostly with blue flowers, and widely distributed throughout the tropics and sub-tropics. The majority are natives of America. The perennial kinds include some excellent garden plants. They have a long flowering season, and are particularly effective when massed. They require protection in winter, and this may be afforded either by covering the crowns over with ashes, or by lifting the roots and storing them in a dry place. *L. cardinalis*, 3 ft., a shortlived, damp-loving perennial with bright-scarlet flowers; *L. Gerardi*, a hybrid attaining to 4 to 5 ft. in height; *L. splendens* (*L. fulgens*) and its varieties, which resemble and are in some ways superior to *L. cardinalis*, but are more prone to disease; and *L. syphilitica*, a very variable species with brilliant blue flowers, are the best of the perennials. They require a rich soil and dislike drought. The very numerous compact and floriferous seedling varieties of the South African annual *L. Erinus* are excellent half-hardy bedding plants. They are to be had in various shades of blue, purple, crimson, and white, and are usually propagated by cuttings, which strike readily in heat, but they may also be raised from seeds sown in a warm house. On the high mountains of Central Africa there are lobelias of tree-like proportions, the stems being stout, unbranched, and the leaves not unlike those of the Musa. [W. W.]

Local Authority.—In any district in England, rural or urban, there are certain local authorities invested with various powers over the district, including the levying of rates. The state of local government in this country, owing to the number of local authorities whose functions sometimes clashed and whose areas intersected, was formerly described as chaotic, but this state of things has been greatly improved by the Local Government Act, 1888 (51 & 52 Vic. c. 41), and the Local Government Act, 1894 (56 & 57 Vic. c. 73). By the former Act County Councils were constituted, to whom various important duties have been assigned, including the maintenance and repair of main roads and county bridges, the maintenance of pauper lunatic asylums, reformatories and industrial schools, the execution of the laws for the repression of contagious diseases in animals and of destructive insects, the protection of wild birds, the payment of half the cost of the county police, the supervision of district and parish councils, the responsibility for secondary and elementary education under the Elementary Education Acts, 1870 to 1902, the provision of small holdings under the Small Holdings and Allotment Act, 1908, and various other matters, and the county rate is raised by County Councils. By the same Act, sixty-one large boroughs were constituted County Boroughs, with the powers, duties, and liabilities generally of County Councils, and additional County Boroughs have since been created. The Local Government Act, 1894, created District Councils, which are either rural or urban. A Rural District Council is the sole sanitary and chief highway authority in its district, and its members are also necessarily Poor Law guardians. Urban District Councils have authority in highway matters in their districts, and also possess many powers, especially in sanitary matters, not conferred on Rural District Councils, though the Local Government Board has power by order to invest a rural council with these powers. In boroughs the mayor, aldermen, and burgesses exercise the powers of an Urban District Council. Urban District Councils have power to raise a general district rate for their expenses, and the expenses of a Rural District Council are raised as an addition to the Poor Rate. In urban districts Poor Law guardians are elected separately from the Urban District Council. The Local Government Act, 1894 also

constituted Parish Councils in every rural parish with a population of 300 or upwards. In any rural parish of more than 100 but less than 300, the County Council must provide for establishing a Parish Council if the parish meeting resolves to have one. If the population does not exceed 100, the County Council may, if it thinks fit, establish a Parish Council, but only with the consent of a parish meeting. Where there is no Parish Council the parish meeting has many of the powers of a Parish Council. The powers and duties of Parish Councils include the powers and duties, other than ecclesiastical, of the vestry, and many other powers relating to recreation grounds, village greens, wells, streams, ditches, footpaths, &c., including under the Small Holdings and Allotment Act, 1908, the duty of providing allotments for the labouring population. They may incur expenses involving a rate not exceeding 3*d.* in the pound. [A. J. S.]

Local Government Board.—The Local Government Board for England and Wales was established in 1871, to supersede the old Poor Law Board. The members of this great administrative body are the President, who is a Cabinet Minister, the Lord President of the Council, the Lord Privy Seal, the Secretaries of State, and the Chancellor of the Exchequer. The Board has a parliamentary as well as a permanent secretary, and a large staff, including a legal adviser, five assistant secretaries, a parliamentary agent, two legal assistants, several superintendents of divisions, a general and numerous assistant medical officers, medical, engineering, and other divisional inspectors and auditors, a bacteriologist, a water examiner, and other officials, besides a large body of clerks of various grades. The estimate of the administrative expenses of the Board in 1907–8 was £232,782. The Board has supreme control over the administration of the Poor Laws, highways, Acts relating to the public health, water supply, sewerage, local taxation licence duties, the finances of local authorities, the registration of births and deaths, alterations in the boundaries of counties, boroughs, poor-law unions, and electoral divisions, motor-car traffic, loans for public works and other purposes, vaccination, the Sale of Food and Drugs Acts, the housing of the working classes, the Workmen's Compensation Act, the Unemployed Workmen Act, Exchequer grants in relief of local taxation, local taxation (customs and excise) duties, the education of pauper children, and other local affairs. The powers of the Board have been constantly increasing in connection with fresh legislation since it was established, and by simply issuing an Order this administrative body has great power over the interests and welfare of the people. There is a separate Local Government Board for Ireland. The corresponding administrative control in Scotland is exercised by a Local Government Board with office and secretary in Edinburgh. [W. E. B.]

Lockjaw, a malady of a very fatal nature, caused by the *drumstick bacillus.* See TETANUS.

Locomotives, Agricultural. See MOTORS, AGRICULTURAL.

Locust Beans, or **Carob Beans,** are the fruits or pods of the Carob tree (*Ceratonia Siliqua*), which is largely cultivated in the Mediterranean regions (see CAROB TREE).

The pods are carefully shaken off the trees whilst unripe, and are then dried by exposure to the sun. During this exposure they ripen, darken in colour, and undergo a slight butyric fermentation which imparts to the pods a faint smell of butyric acid. As much as 100 lb. of dried pods is sometimes obtained from a single tree. The dried pods are smooth-skinned, very hard, and almost black. They contain hard seeds embedded in material which is very rich in sugar and starch. The best qualities of beans are largely reserved for human consumption, the remainder being either exported or used locally as food for horses and fattening stock.

The value of locust beans for feeding purposes is determined largely by their richness in sugar and starch, notably the former, some samples containing as much as 45 or even 50 per cent of sugar. The locust beans grown in the south of Portugal and also those from the eastern Mediterranean regions are usually pre-eminent in this respect.

Subject like other natural products to great variations in composition, locust beans contain, on the average, about 6 per cent of albuminoids, 1½ per cent oil, 70 per cent soluble carbohydrates, 6 per cent crude fibre, and 2 per cent ash. Of the albuminoid matter about two-thirds is digestible, whilst the carbohydrates are almost completely digested, the albuminoid ratio of the food thus being about 1:20. The sugar consists of roughly equal proportions of ordinary sugar (sucrose) and glucose, and forms as a rule about two-fifths of the carbohydrates, starch forming about one-third.

The beans are relatively rich in astringent matter (tannin, 1·8 per cent), and contain also usually about 2 per cent of butyric acid.

The seeds contained in the beans are very hard and difficult to grind. They swell up considerably with water, and hence should be thoroughly soaked before use.

Owing to their hardness, locust beans are, in this country, commonly ground to meal, and in this form are greatly relished by all classes of stock. Owing to its appetizing flavour, locust-bean meal is, moreover, a favourite ingredient of condimental and other special foods. It is most useful for fattening animals, being found to have a beneficial influence on the quality of the meat. For this reason, along with its stimulating action on the appetite, it is esteemed by many feeders for the later stages of fattening. Its poverty in albuminoids renders it less suitable, except as a flavouring ingredient, for the food of milch cows or growing animals. [C. C.]

Locusts is the name popularly given to those grasshoppers of the family Acridiidæ which, on account of their gregarious and migratory habits, are capable of inflicting enormous injury on cultivated crops. The European migratory locust is *Pachytylus migratorius*, but various species are found in different parts of the world, especially in the hotter regions.

The habits of all are much alike, and may be summarized as follows.

The female locusts deposit packets of eggs just below the surface of the ground. The eggs are not, as a rule, laid among herbage or growing plants, but arid tracts of sandy soil are usually selected for the purpose. The insects which hatch out are like the parent except for the small size, the whitish colour, and the absence of wings. They feed for a time on herbage near at hand, and when this is exhausted they migrate, sometimes in vast hordes, to new regions, eating off every green leaf as they go. They progress by leaping, and are often spoken of as 'hoppers', or, in South Africa, 'voetgangers'. As they increase in size they periodically cast their skins, and it is not till after the last moult that they are fully winged, though 'wing pads' appear after the last moult but one. The mature winged locusts are, of course,

Locust

much better equipped for seeking out new food supplies, and may compass great distances with a favourable wind, and their sudden appearance may mean the destruction of all crops over a large area. Presently they pair, and the females seek out ground suitable for egg laying.

In combating them it is of extreme importance to find out, if possible, where the eggs are laid, and to plough up the soil containing them. It is also possible to do much to stop the advance of the 'hoppers', which can easily be destroyed by myriads. Various contrivances (called 'hopperdozers' in the United States) have been invented for the purpose, and the primitive method of digging a trench and beating the young locusts into it with palm branches and covering them with earth is fairly effectual. As an indication of the enormous multiplication and capacity for mischief that may be manifested by these insects, it may be mentioned that in Cyprus, in a single season, locust eggs to the aggregate weight of over 1300 tons have been collected and destroyed; while a single flight of locusts has been estimated at 2000 square miles in extent (Ainsworth Davis, Natural History of Animals). [C. W.]

Locust Trees.—There are various trees known popularly by that name, chiefly the Locust tree of Palestine (*Ceratonia Siliqua*, the Carob tree), the Locust of the West Indies (*Hymenæa Courbaril*), and the False Acacia tree (*Robinia Pseud-acacia*); all these are members of the *Leguminosæ*. The most important is the Carob, the Algaroba of Spain. It is a slow-growing low, and much-branched tree, indigenous to the eastern Mediterranean region and to Syria. It has been diffused in modern times to all warm temperate, and to some extent also to tropical countries, provided both soil and atmosphere are fairly dry, and the subsoil calcareous. It is accordingly of special value to countries subject to droughts. It is said that the finest qualities are to-day produced in Cyprus. But its regular cultivation seems only to have been undertaken in historic times, and by the Arabs originally. To obtain the finer qualities, grafting is essential. The pods, full of sweet pulp, are a common article of food throughout the area of systematic cultivation, and horses, cattle, pigs, and to some extent men also, are fed on it. Large quantities are used in England in the preparation of certain cattle foods, and it is believed the meat of sheep and pigs is improved by a diet of locusts. Horses are said to take readily 6 lb. of the crushed pods, raw or cooked, and with or without an admixture of chaff. Sugar, pectose, gum take the place very largely of starch in other food substances, and accordingly locusts are heat-givers of less nutrient value than starch foods. The imports into Great Britain seem to be steadily increasing. In 1903 they came to 632,756 cwt., valued at £157,068, and had increased in 1907 to 972,006 cwt., valued at £232,113. About one-half comes from Cyprus, a little less than one-third from Portugal, and the balance from Algeria and Turkey in Asia. [G. W.]

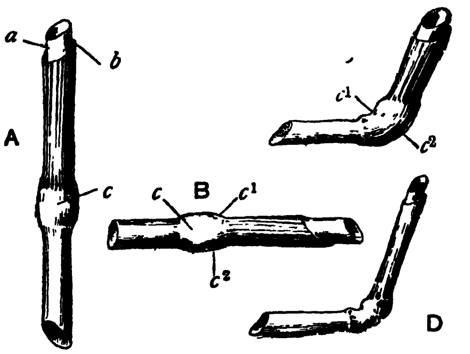
Lodging.—This term applies to grain crops. The crop is said to have lodged when the straws of the cereal are laid flat by wind or rain or other cause. Such lodging, of course, interferes with the ripening of the crop, and the amount of interference is determined by the duration of the lodging. For a laid grain crop may, and often does, rise up again. This power of rising up depends upon certain peculiarities in the structure of the straw stem. At certain points, the straw remains tender and capable of renewing growth. Such a growing region of the straw lies within each knot of the leaf-sheath. Now, when the straw is laid, this growing region is excited by the stimulus of gravitation, the growth begins again, and is more energetic on the lower side than on the upper. Thus a knee-like curve is produced on the straw by means of which the erect position is quickly restored, and the crop is no longer lodged.

Lodging is, of course, more easily brought about when the straw, especially the base of the straw, is deficient in firmness and rigidity. It used to be said that lodging was due to deficiency of silica in the straw, that it was silica that gave firmness; but now we know, thanks to water-culture experiments, and to progress of microscopic methods of observation, that the firmness is due to the organic compound called cellulose, that want of firmness is due to deficiency of cellulose, and that brittleness is due to silica. In point of fact, the straw of lodged

crops usually contains more of the glassy silica than the straws of crops which have not lodged.

When corn that has lodged is examined, it is easy to notice that the basal part of the straw is abnormally slender and abnormally long. Microscopic examination of these weak parts shows further, that the component cells are thin-walled, that the cells which should be thick-walled are thin-walled instead; in short, that cellulose is deficient, that the skeleton as a whole is defective.

This defect is due to various causes. In the first place, want of light would lead to deficiency of cellulose. All know how the close planting of trees 'draws them up', and close planting, of course, means shading, that is deficiency of light. Corn liable to lodge is in the same plight as 'drawn-up' trees. Again, excess of nitrogenous manure produces much the same effect as excess



A, Haulm in normal position before lodging; (*a*) straw, (*b*) sheath, (*c*) knot. B, Haulm lodged; both sides of the knot being of equal length. C, Haulm after lodging; the under side of the knot (c^2) has somewhat lengthened, the upper (c^1) has shortened; as a result of this, the haulm has been raised through an angle of 75°. D, The knot subsequently cracked.

of shade, for the manufactured sugar which would normally be used up in the formation of skeleton is largely diverted now to another use — the formation of amides — and so the skeleton is defective.

The point at which the nitrogenous compounds may be said to be in excess depends to a large extent upon what goes along with them, and, above all, on the amount of phosphate. Certain varieties of grain crops, however, can stand much heavier manurial dressings than other varieties, without lodging. Among oats, for example, those varieties that are specially heavy grain yielders can stand much more forcing than straw-producing oats such as Sandy and Potato. The explanation is that varieties least liable to lodge have less tendency to lengthen out the basal internodes, and less tendency to diminish the bore and thickness of the 'pen' surrounding the cavity within the straw. Wind and rain are potent factors in laying straws, and the greater the surface of the ear the more potent do such factors become.

To prevent lodging, special varieties of grain crops should be selected, namely those that experience has shown to have least tendency to lodge; care should be taken also as to the amount of nitrogenous manure that can with safety be applied, and, above all, the rate of seeding should be such that the young plants do not shade each other. Take oats, for example; the variety called Tartar King does not readily lodge. It can stand heavy manurial dressing, and the rate of seeding should not exceed three million seeds per acre.

The disadvantages that arise from lodging of the grain crop are, diminished yield of grain rather than of straw; and if grasses and clovers have been sown with the grain crop, the clovers may suffer severely if lodging of the grain crop has occurred to any considerable extent.

[A. N. M'A.]

Loess or **Löss** is the term (adopted from the German) for a calcareous earth of medium grain, somewhat coarser than a true clay, readily porous, but drying in a coherent form after being wetted. It is traversed by small passages, which are formed by the rootlets of grasses, and calcium carbonate has often separated out round these, giving rise to calcareous tubules. In some cases, calcium carbonate cements the grains together. Loess is usually pale-yellow, and forms a structureless mass, filling up hollows over a wide extent of country, and accumulating in thick banks against mountain slopes. Von Richthofen, supported by a large number of later authors, has urged that regular winds blowing in one direction are the main agent in forming loess deposits. Winds thus carry away the fine dust from dry regions, such as deserts, and accumulate it in other regions where obstacles are met with. Such obstacles are provided by vegetation, notably on steppes, where the stems of grasses and twigs of other plants become surrounded by the dust, which deepens and deepens round them. Gradually old hills and vales may be obliterated by the growing mass; new vegetation continually arises above the old, while the tubules in the dry earth allow of the easy percolation of water. The surface thus dries rapidly, and the streams run, as in the great loess areas of China, in subterranean channels, or in deep narrow valleys, along which the trade routes of the country have to be carried. Loess cannot accumulate where there are heavy rains, which would lead to its being washed away again. Wahnschaffe, however, regards the loess of Europe as deposited in lakes which were formed about the close of the glacial epoch. The calcium carbonate is then easily explained as having been formerly in solution in the water; but land snails are frequent in loess, it is unstratified, and it has many characters that suggest that its constituents, even if originally transported by water, were finally accumulated on a land surface. Professor I. C. Russell points out how rains in regions that are dry for most of the year easily wash out the finer material from hillside taluses; when the rains are over, the winds set to work to distribute the fine sand and clay as loess. Wahnschaffe finds that the loess of North Germany consists mainly of quartz particles between ·05 and ·01 mm. in diameter, its uniform grain being one of its characteristics. It has gathered on the margins of the great Prussian plain, especially in north-

ern Saxony and the lower valley of the Rhine, where, as in China, it forms a soil of great fertility. The loess of the drier regions of the United States has raised, in spite of its porosity, excellent crops of wheat. [G. A. J. C.]

Logging of Timber after the tree is felled by axe or saw should be carried out in such a manner as to give the largest yield in quantity and in value; and this, of course, depends upon the length of the trunk and the extent to which it tapers. Trees grown in fields, parks, hedgerows, and copsewoods generally give only one good log up to the first or main branch, and a much smaller and usually shorter log above that. But the logging is so entirely dependent on the particular manner of growth of each kind of tree, and of each stem, that it would be misleading to attempt to give any average number of logs for a given number of trees. The cross-cutting of logs is always done by two-handed saws; but for cross-cutting into sleeper lengths, &c., at a mill or depot, Ransome's Steam Tree-feller is a very useful machine. In Britain wood merchants usually contract for the felling, trimming, and logging of timber in a lump sum, averaging from about 2*s.* to 4*s.* per load of 40 cu. ft. for hardwoods (Oak costing most), and 1*s.* 6*d.* to 2*s.* 6*d.* for softwoods and conifers. But prices vary considerably according to local conditions regarding labour, and the kind and quality of the timber. When logged, timber has to be numbered serially; and a revolving numbering hammer is the most convenient instrument to use for this purpose. [J. N.]

Logwood, used in dyeing, is the hard, dense, dark-brownish-red heartwood of the leguminous tree *Hæmatoxylon campechianum*, indigenous to Central America, but cultivated in the West Indies. It grows to about 30 to 40 ft. high, but is marketable when about ten years old, when it is felled, cleared of bark and sapwood, and cut into blocks and faggots. When required for use in dyeing, the wood is chipped or rasped, then moistened to induce fermentation. This liberates the colouring principle, hæmatoxylon, which soon oxidizes into bright metallic-green crystals of hæmatin and develops a fine purple colour. Or a solid brittle black logwood extract, used in calico printing, can be obtained from oxidized chips and raspings, the solution being concentrated at a low temperature. Chiefly used as a wool dye, logwood produces various shades of blue, varying according to the mordant. But it is also used with bichromate of potash to finish indigo-dyed wools and produce the best permanent black ('woaded black'). The imports of logwood into Britain in 1907 amounted to 23,105 tons, valued at £112,744. [J. N.]

Lolium is a genus of grasses distinguished by the following characters: (1) The underground base of the leafy shoot is red. (2) The ear is a two-rowed spike. (3) The spikelet is many-flowered, and placed so that its edge is next the axis of the ear. (4) The stalk on the inner face of the seed is flat, not cylindrical. Three species belong to this genus:—

1. Perennial Rye Grass (*Lolium perenne*), a bottom hay and pasture grass, with flat shoots, and an ear which is beardless (without awns). This grass often lasts only a few years.

Perennial Rye Grass (*Lolium perenne*)

2. Italian Rye Grass (*Lolium italicum*), a top grass grown for hay, with round stout shoots, and an ear which is bearded (awned). This species is less lasting than Perennial Rye Grass.

3. Darnel Rye Grass (*Lolium temulentum*), a poisonous annual sometimes occurring in the grain crop. The ear is awned as in Italian Rye Grass, but the glume of the spikelet is as long as the whole spikelet, not half as long. The poisonous property of Darnel seeds is due to the presence of fungi. When the fungi are absent, the seeds are not poisonous. See DARNEL (where there is a fig.), and also RYE GRASSES. [A. N. M'A.]

London Clay, a strong bluish clay which forms one of the strata of the Eocene system in the London Basin. This clay, which contains both sulphide and carbonate of iron, is largely used for making bricks. See art. EOCENE SYSTEM.

London Pride, a pretty little plant, well known in gardens, where it has for long formed an ornamental addition to rockeries and flower-borders. It is one of the flowers which is able to withstand the smoky atmosphere of the great metropolis, and on this account has been given the name London Pride. See SAXIFRAGE.

London Purple, a by-product obtained in the manufacture of certain aniline dyes, and composed mainly of arsenite of lime. It is often used as an insecticide. See ARSENIC COMPOUNDS and INSECTICIDES.

London Rocket, a cruciferous weed with small yellow flowers which grows in waste places and by roadsides. It derives its name from the fact that it sprung up in great quantities in the ground laid waste by the Great Fire of London in 1666. See SISYMBRIUM.

Long-eared Owl. See art. OWLS.

Longhorn Cattle.—Amongst the many pure breeds of cattle in England to-day the Longhorn may justly be regarded as the oldest, for in the earliest days, as far back as agricultural history takes us, we find it referred to, both as the principal breed and also the purest in existence. Its origin is still, and we fear will ever be, shrouded in mystery; but, from the evidence to be got from the various ancient histories of the breed, we feel we may credit the Craven district of Yorkshire, and perhaps the northern part of Lancashire, with the honour of producing this grand old breed of cattle. Early reference is also made to herds kept in Cumberland and Westmorland; and that the Longhorn also had a very firm footing in the Emerald Isle at an extremely early period of its history may be vouched for by the fact that the present herd owned by Lord Westmeath on

his estate in Co. Galway is believed to have been bred there in a pure state for over two hundred years. This fact may partly account for Ireland's claim to be the original home of the breed, for on reviewing the ancient breeds of cattle of that country, we find the Longhorn frequently referred to and highly spoken of, the old-time breeders being of opinion that during transit to our metropolitan markets many of their best specimens were arrested by English farmers, who thus laid the foundations of their herds with Irish-bred stock. We feel justified, however, in disbelieving their theory. Some of the midland counties of England also claim to be the home of the breed, but whether or not this is so remains to be proved. The Midlands must, however, be given full credit for the great improvement that has been effected in the Longhorn, and certainly from quite a remote period up to the present time these counties have been the stronghold of the breed.

In early days there appears to have been two distinct classes of animals, one considerably smaller than the other. The smaller kind inhabited the mountains and moorlands, were very hardy and useful, and being easily maintained were largely owned by cottagers and small farmers, who kept them mainly on account of their great dairy qualities, for they were noted as having been producers of a large quantity of rich milk; they were also rapid fatteners when allowed access to better pastures. The other kind were larger, and inhabited the more level and richer portions of the country; it was as butcher's beasts that they were particularly adapted, on account of their readiness to lay on flesh; and their great carcasses made them equal to the much-improved Shorthorn of that time.

As far back as 1720 we read of Sir Thomas Gresley, of Drakelow House, Burton-on-Trent, keeping a pure herd in which he took great pride; but the first man who is credited with having set about the improvement of the breed in real earnest was a blacksmith named Welby, who lived at Linton, in Derbyshire, where he rented a small farm. His stock consisted of a herd of cows which came from Sir Thomas Gresley's. He was, however, overtaken by misfortune, and lost nearly the whole of his stock through disease. A Mr. Webster of Canley, near Coventry, was the first to follow Welby's example, and he did much to improve the breed. Working as his predecessor had done, on Sir Thomas Gresley's stock, he quickly got together a herd of great repute, representatives of which were much sought after by his fellow-breeders and admirers. Following Webster was the renowned Thomas Bakewell, who may justly be styled the pioneer of the breed. He was born at Dishley, in Leicestershire, in the year 1725, and from his earliest youth had shown more than ordinary intelligence in agricultural pursuits and stock-raising. Travelling through most districts in England, Bakewell studied the different breeds of stock, and eventually decided in favour of the Longhorn. Being struck by the quality of Webster's stock, he purchased two heifers from that breeder, and a bull to mate with them from Westmorland, so that it will be seen that the foundation of Bakewell's herd also was laid with blood from Sir Thomas Gresley's stock. These formed the nucleus of the Dishley herd, and on them alone, through in-and-in breeding, Bakewell brought his herd to great perfection and world-wide repute, so much so that for a long time after the breed was more familiarly known as the Dishley, or New Leicester breed. This great improver must be credited with much and blamed for little; perhaps his one fault, so far as Longhorns were concerned, was that he lost sight of their milking qualities in his keenness to produce an animal with less bone, more fat, and a greater tendency to early maturity. He set about his task in 1750, and prior to his death in 1795 had not only been successful as an improver of cattle, but had also made the Dishley sheep and horses alike famous under his judicious management.

It is to be regretted, however, that the system of close in-and-in breeding adopted by Bakewell, and afterwards carried on by many other breeders, eventually caused the Longhorn to degenerate, and, as a consequence, we find that during the greater part of the 19th century the breed declined greatly in public favour. Of the many splendid herds kept in various parts of the country during that period mention may perhaps be made of those belonging to the late Duke of Buckingham and Chandos, Stowe; Sir J. H. Crewe, Bart., Calke Abbey; Colonel Inge, Tamworth; and Mr. R. H. Chapman, Upton, Nuneaton.

In the very early days of the breed, cheese and butter making were the chief objects of farmers, and indeed in this capacity the Longhorn had then no equal; and at a much later period in its history, when the Shorthorn was fast becoming the more popular of our pure breeds, a trial was conducted between representative herds of the two breeds, with the result that as a cheese producer the Longhorn proved its undoubted superiority over the Shorthorn, the greater richness of its milk over that of the Shorthorn producing by far the greater quantity of curd. It may be that the Longhorn had something to do with the manufacture of the first Stilton cheese, which is supposed to have originated at Wymondham, in the Melton district of Leicestershire, somewhere about the time of the great improvement in the breed.

The Longhorn is particularly hardy and of a robust constitution, and will thrive well in almost any situation. In shape it is naturally of great length, very short on the leg, with well-sprung rib and a wide and level back; the hide also, which is mellow to the touch, is well and thickly covered with nice silky hair, which with the advent of winter becomes more profuse and stands rather rougher, so that the animals are enabled, with little or no shelter, to withstand the wintry blasts, and come through those dreary months looking very fit. The colours are somewhat varied, but what one might almost style the characteristic mark is a white line along the back, which, however, is not always found in pure-bred animals, though

possessed by the majority; some animals are entirely self-coloured, and others are either red, grizzled roans, or brindled on the sides of the body; sometimes these colours are intermixed with specks or flakes of white, but this does not deteriorate the value of the animal in the least. Breeders fancy most the dark brindle colour with its bluish tint and the orthodox white line, and certainly this gives the animals a most attractive and hardy appearance. The horns which give the breed its name must be long, and may grow in any shape, some coming out at right angles, others curving and almost meeting under the jaw, whilst many assume very artistic shapes and add much to the general picturesqueness of the breed. The females have large and square udders with teats of a good size, and will give up to 5 gal. milk per day, and are capable of making up to 18 lb. butter per week, their milk coming second only to that of the Jersey in point of richness. Being of a quiet disposition the Longhorn is a good feeder, and will rest well in the pastures at any time. Considering their great size, these animals are comparatively small consumers of food, and being of so hardy a nature are amongst the cheapest breeds to winter; young stock, unless being carried on for show purposes, will do well if foddered once a day in the open field with hay or bright, clean straw, and indeed when there is plenty of rough pulling they will get their own living entirely.

Used for crossing purposes the Longhorn is one of the most successful sires that can be found, its extreme hardiness and great size, together with its wealth of flesh of the best kind, making it a very desirable animal for the purpose. One of the chief breeds with which this sire is mated is the West Highland, and the result obtained is generally very gratifying, the Longhorn tending to increase the size, whilst the shape and colour of the offspring leave little to be desired; and it will generally find its way into the butcher's hands at about two and a half years old, leaving a good margin for profit. Another very successful union is the Longhorn bull and Aberdeen-Angus heifer; steers from this cross have made just upon £40 each in the Christmas markets at under three years old. Yet another successful blending is that of the Longhorn and Shorthorn, a cross that has been very successful both in the earlier history of the Longhorn and also at the present time, and is usually productive of milk and early maturity, giving great size and splendid quality of beef. The breed is seldom represented at our larger fat-stock shows at the present day, but we find that at the Smithfield show of 1847 a heifer of the Longhorn-Hereford cross won the gold medal as the best female in the show; and as an instance of the former popularity of the breed we have it on record that at the Warwick and other fairs the Longhorn used to outnumber other breeds by ten to one. A point of interest in this connection is that the actual proposer of the Smithfield Club in 1798 was a Longhorn breeder.

Dealing with the more recent history of the Longhorn we find that in 1878 an effort was made to form a society to further the interests of the breed, and that in the same year the late Mr. John B. Lythall, of Birmingham, as secretary of the Longhorn Cattle Society then formed, brought out the first volume of the Herd Book, giving particulars of the pure herds then existing in the country; and although the animals entered were not very numerous, they consisted mostly of the best blood the country ever possessed, being remnants of the purest and oldest-established herds in existence at that time, and it is from these that the present-day herds are descended. After Volume I had been published we hear of very little being done for the breed in an official way for a considerable period, the old society apparently having gone no further, and the breed was allowed to return to its former state. Something like twenty years afterwards, however, a fresh effort was made to revive the breed, and in 1899 the late Mr. T. H. Weetman, as secretary of the new society then formed, published the second volume of the Herd Book. Several fresh herds were formed up and down the country, and the society soon got together a fair number of breeders and others interested in the Longhorn. Since then it has continued to make steady progress, and the year 1908 saw the publication of Vol. VI of the Herd Book. No doubt much of the new interest was due to the Royal Agricultural Society of England reopening its schedule to the breed in 1898, when classes for both sexes were given; this, we are pleased to state, has been continued regularly ever since.

Herds are found to-day in many counties of England from north to south, but the midland counties are still the stronghold of the breed. Perhaps it will be well to mention the following counties (all of which contain one or more pure herds): Dorset, Kent, Hereford, Worcester, Warwick, Leicester, Northampton, Hertford, Buckingham, Stafford, Norfolk, and as far north as Cumberland, whilst the Isle of Man and Ireland are both to be added to the list. Reviewing briefly the herds in existence at the present day, that belonging to the Lady Mary Baroness Kinloss of Stowe, Buckinghamshire, rightly deserves premier mention. This herd has reigned at Stowe for a very long period, and the present animals are direct descendants of the famous stock kept by the late Duke of Buckingham and Chandos, and are very characteristic of the old breed. Although shown but little of late, the herd has nevertheless had a good run of showyard successes, some very formidable opponents of both sexes having been placed high up in the honour lists, both at the Royal Agricultural Society's meetings and also at county fixtures. At Wychnor Park, Burton-on-Trent, Mr. T. Basil P. Levett has an old-established herd, and animals bearing the prefix 'Wychnor' are frequently hard opponents at our shows, and in many cases have been successful in carrying off the coveted honour. Another of the oldest-established homes of the breed is at Fradley, near Lichfield, where Mr. W. S. Shaw, jun., still retains some very worthy representatives, good alike for show and utility purposes, bred from the stock of his father,

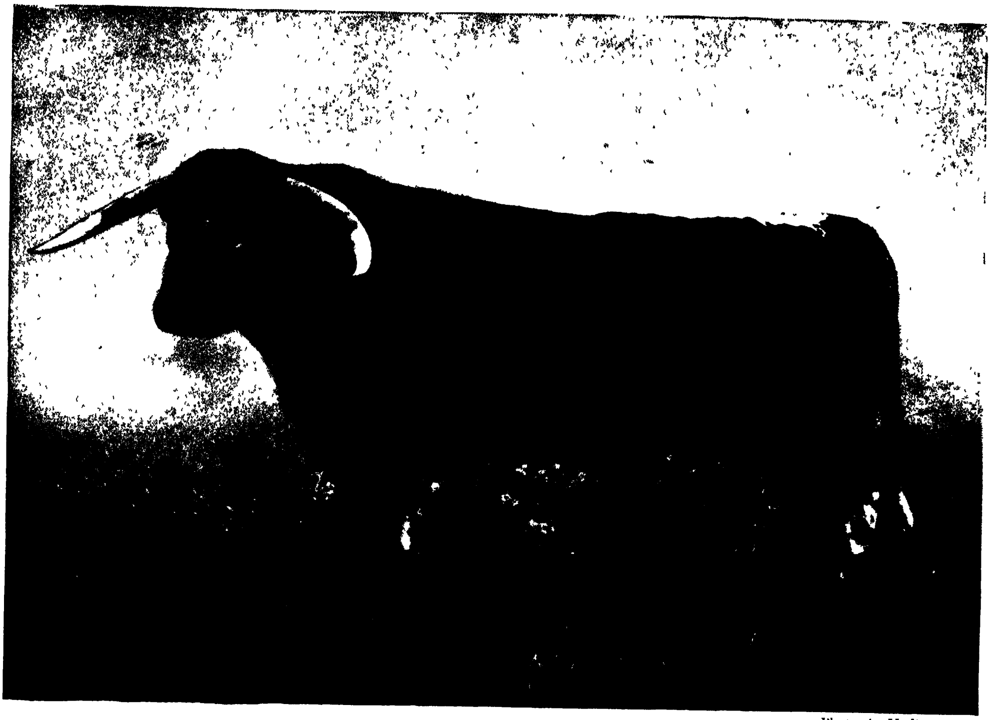
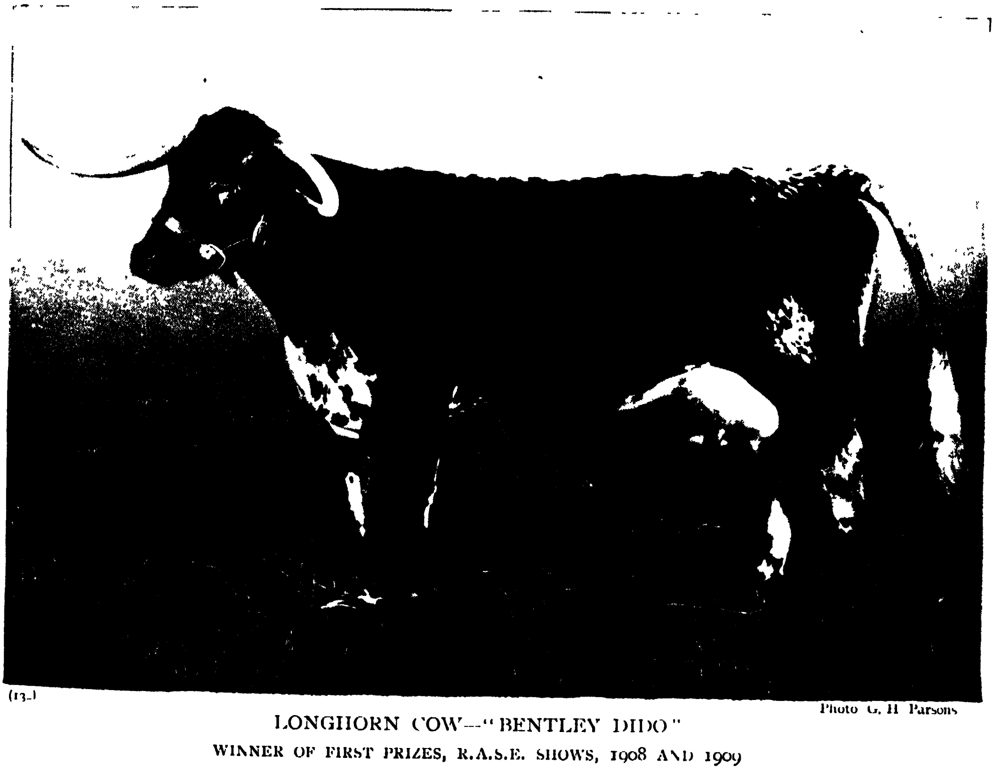


Photo. G. H. Parsons

LONGHORN BULL—"EASTWELL EMPEROR"

FIRST PRIZES AT R.A.S.E. AND WARWICKSHIRE SHOWS, 1909



(13.)

Photo G. H. Parsons

LONGHORN COW—"BENTLEY DIDO"

WINNER OF FIRST PRIZES, R.A.S.E. SHOWS, 1908 AND 1909

Mr. W. S. Shaw, senior, who is the oldest member of the Longhorn Society. In Northamptonshire the Hon. A. E. FitzRoy keeps a very extensive herd, where, apart from showing, a large number of steers are annually prepared for the Christmas markets, and some very remarkable animals have been thus brought to public notice. At the Northampton Christmas market of 1905 a steer from this herd won the champion prize over all breeds, in very keen competition, at the age of three years and three months, his live weight being 19 cwt. 1 qr. 16 lb., dead weight 173 st. (Smithfield), his price under the hammer being £40. This clearly demonstrates that the Longhorn can grow into excessive weight for age and at the same time retain his quality and fleshy constitution, with an absence of superfluous fat. Probably the most noted of the present-day herds is that of Mr. W. H. Sale of Atherstone, Warwickshire. For a long time after the publication of Volume II of the Herd Book, the Arden Hill herd held premier position in most of our show yards, counting amongst its long list of honours many firsts and other prizes won at the Royal and county shows, as well as a silver cup offered at the Warwickshire show of 1906 for the best representative of the breed, either male or female, this trophy falling to the very typical young bull Arden Conqueror, which was bred in the herd. Lord Gerard also has a herd of great fame on the beautifully wooded estate of Eastwell Park, in Kent, and recently animals from this herd have been decorated with a goodly number of winning rosettes at the Royal and Warwickshire shows. Experiments in crossing the Longhorn with other beef-producing breeds are also largely practised in this herd with very gratifying results.

In the county of the Whitefaces is yet another of the breed's enthusiasts in the person of Mr. John Riley of Putley Court, Ledbury, who is doing much in his extensive herd to further the interests of the Longhorn, his chief aim being to bring the herd up to the highest possible standard of excellence as dairy beast—a point which had been neglected by many breeders up to recent years, but which has of late received more consideration, and is being productive of splendid results. In Dorsetshire Mr. F. J. Mayo has a herd of considerable extent, kept exclusively for dairy purposes, in which capacity it has held its own for a considerable time. There is also a small herd still kept by Mrs. Cheape on her Worcestershire estate which has produced many winners from time to time. Another herd that is generally productive of good results, particularly towards Christmas time, is that of Mr. E. Tingey's in Norfolk. Steers from this herd have won cups and prizes against all-comers at the King's Lynn auctions, and have realized up to £46 per head under the hammer, whilst his Longhorn crosses also have made up to £40 each in the same auction. In Leicestershire several herds of great dairy qualities are kept. Mr. H. Houghton of Osbaston breeds a wonderful class of animal entirely on its dairy merits which are kept in very ordinary condition, roaming the pastures both in winter and summer, and in spite of the hardships thus endured many of its members will milk 4½ gal. per day. Mr. C. Tollemache Scott of Bosworth Park is another energetic breeder, and his herd too contains several rosetted animals as well as good milkers. Mr. S. B. H. Chamberlayne, in the same county, also has a uniformly good herd which is kept and bred on similar lines, and contains cows with large and shapely udders. Amongst other successful breeders may be mentioned Mr. W. L. Riley of Coventry, whose animals are frequently high up in the show list; Mr. G. H. Tanser, in Leicestershire; Mr. E. S. Hanbury of Poles, Hertfordshire; and Mr. Watson, of Cumberland, where many prize-winners have been bred, and where in years gone by the breed had such a reputation. Mr. J. C. Bacon, in the Isle of Man, is also a breeder and a great enthusiast, doing much to further the growing interest taken in the breed on the island; whilst Lord Westmeath's herd in Co. Galway, Ireland, is still in a very flourishing condition, though it is but little heard of on this side the channel. As late as the year 1902, however, this herd furnished steers good enough to carry off second prize at the Royal Dublin Society's Christmas show in a very strong mixed class of Angus, Herefords, and Shorthorns, as well as numerous crosses.

As the breed is in the hands of comparatively few fanciers, and a good private demand generally experienced, we do not hear of many animals finding their way to the auction ring; towards Christmas, however, some excellent steers may be seen in some of our markets, when in addition to winning, in many cases, cups and other prizes in keen competition, as much as £46 has been paid for one animal under the hammer.

Up to the present our Colonies have not been tempted to give the breed a trial; but as the Longhorns are such excellent dual-purpose animals, and readily adapt themselves to any change of climate, one may hope for the time when they will be sought after by our brethren across the water. [J. M. W.]

Longmynd Beds.—These sandy and conglomeratic strata were formerly classed as Cambrian, but are now known to be older than the base of that system. They form a moorland ridge west of Church Stretton in Shropshire, mostly covered with heather, and furnishing streams of pure water to the lower lands. Sheep-farming is carried on upon this local highland, and at one time a special type of sheep was bred there. [G. A. J. C.]

Long-woolled Sheep are peculiar to England. The Blackfaced breed of Scotland, although long in the fleece, is not classed among long-wools, but as a mountain breed. The best specimens of the true English long-wools produce fibres of 23 in. in length, and the entire fleece may weigh as many pounds. The Lincolns may be taken as a representative type, and no doubt at an early stage were crossed with the Leicester, which is not a true long-wool. The principal long-woolled races are the Lincoln, the Kentish and Romney Marsh, the Devon long-wools, and the Cotswolds. The Wensleydale sheep is another and more recent example,

and Mr. W. Parlour of Croft, Darlington, states that their wool is of pure lustre character, silky in handle, and classed as 'long-wool', the fleece occasionally reaching 21 in. in length.

It would be misleading to give the impression that long-woolled sheep usually yield such enormous weights of wool; but in noted flocks of Cotswolds an average has been attained of two fleeces to the tod of 28 lb., and three to the tod is common. The peculiar character known as 'lustre' has been claimed as a speciality of Lincoln wool, and it has even been asserted that this quality disappears when the sheep are bred away from their native county. It may be described as a silvery, glistening appearance, exhibited by the fleece as it is shorn from the skin, very different from the duller white of other fleeces. Long-woolled sheep are mostly confined to the richer soils of the country (Cotswolds excepted), and both the quantity and quality of the wool is probably due to environment assisted by careful selection. It has been observed that the wool of other races alters in character when they are removed from their natural habitat, as is the case with Southdowns; and it is found necessary in such cases to repair to the fountain-head in order to maintain the type. True long-woolled sheep are the denizens of rich lands such as the fens of south Lincolnshire, the Kent marshes, the rich soils of Devon, and the pastures of the Yorkshire dales.

Lincoln sheep have been known to scale 360 lb. carcass weight, and the other long-woolled breeds are not far behind. Their wool is curly as on the Cotswolds, or massed over the carcass as in Lincolns, Kents, and Devon long-wools. The faces and shanks are white, and the fat is laid on under the skin, on the back, loins, and ribs. The flesh is paler and longer in the fibre than in the case of short-woolled sheep, and does not command so high a price. Taking the wool and flesh together, the value of a long-wool teg when wool was dear was often about £5. This the writer was assured of by a noted Lincoln sheep-breeder when wool was fetching 2*s.* and more per pound. Readers are referred to special articles upon all the breeds above named.

[J. Wr.]

Lonicera (the Honeysuckles), an extensive genus of deciduous or evergreen shrubs (nat. ord. Caprifoliaceæ), some being of twining habit. They are chiefly natives of the temperate and sub-tropical regions of the northern hemisphere. The fragrant flowers are variously disposed, and owing to the length of their tubes, are for the most part fertilized by long-tongued hawk-moths which visit them at night. The British species (*L. Periclymenum* and others), so prominent among the glories of our hedgerows, are invaluable for covering arbours, trellises, &c., in gardens, and should be supplemented by a selection of the exotic kinds. Most notable among these are: Climbers or trailers—*L. etrusca*, South Europe (requires a sheltered position), *L. Halliana*, and *L. japonica* and var. *aureoreticulata*. Shrubby species—*L. fragrantissima* and *L. syringantha*, China, and *L. tatarica*, Siberia. *L. pileata*, a dwarf evergreen Chinese species of recent introduction which is strangely unlike the conventional Honeysuckle in appearance, is well suited for a place in the rock garden, or for a position in the front of a border of shrubs. Lonicera are also very suitable for a place in a cool greenhouse. They are of easy cultivation, and are usually propagated by cuttings. A few of the species produce their flowers on wood of the previous year's growth, and these must not be pruned until after flowering, but the majority flower on the young wood. Some plants belonging to other genera are also known as honeysuckles, notably *Azalea viscosa*, the Swamp Honeysuckle of North America.

[W. W.]

Lonk Sheep. — The Lonk or Improved Haslingden is a large mountain breed found occupying the exposed positions in north-east Lancashire, the West Riding of Yorkshire, and North Derbyshire. The towns Colne, Skipton, Clitheroe, and Nelson may be looked upon as central districts, but the breed stretches northwards over Bowland Moors towards the Lancaster moors, north-eastward towards Leeds, and southward beyond Bacup, after which it is gradually superseded by the Penistone breed. The Lonks are considered an offshoot from the Scotch Blackface (though many breeders dispute this point), having been brought to their present position by continued selection and careful breeding. They resemble the Blackfaced, but are much larger and more lengthy in the frame, and longer and stronger in the leg. The head is bigger, with finer horns in the male and stronger horns in the female. They are possessed of great cunning and are good rangers. The ewes are fairly prolific and are excellent milkers. They are a particularly adaptable breed, for although their home is on the dry exposed hills amongst the heather, they do well on damp soils, indeed under almost any conditions. They are, however, considered less hardy than the Blackfaced.

Many thousand Lonks are kept in the districts above named, and with the great call for pure-bred rams that was witnessed in the autumn of 1907 they are likely to keep on the increase. As a rule the flocks are small, ranging from 200 downwards, but flocks of 500 or even more may be met with. In some cases they are the property of the landlord, and are rented with the farm, in a similar way to the Herdwick flocks. A few rams have been exported to Austria-Hungary and America, but with what success is not yet known.

CHARACTERISTICS.—There seems to have been little change in type during the lifetime of the present generation of breeders, and there is no indication of any change at present. The following may be taken as including most of the points of the breed:—

Head—large and strong, nose Roman, fine at the tip. The colour of the face shows great variation; a clear black and white is desired, any mixture of the colours or brownness being objectionable. In some specimens the black preponderates, as in Walker's ram 'Pride of Warfedale'; in others the white, as, for example, in Hague's 'Worsthorne Wonder'. Some judges favour the former type, others the latter. Excess of white is considered a sign of weakness, but proof of this is wanting. The horns spring horizontally from the back of

the head in the male, the tips curving gently downwards and forwards; a second curve being formed when older. The bases of the horns hold the ears behind them in a somewhat unnatural-looking position. In the female the horns are weaker, shorter, and straighter, rising a little more on springing from the head than in the male, and having the ears in front of them. The ears are medium-sized, and usually correspond to the legs and face in colour. The forehead should have a tuft of wool.

Neck—strong, short, and well covered up to the face with wool.

Shoulders—fairly well fleshed, but handle badly at the top; the breast is well forward.

Body—lengthy, wool well down sides and down to hocks; back rises at the shoulder, the backbone being rather prominent at this point when clipped. Legs strong and bony, good length, free from wool except a small fringe on hind legs; colour same as the face. Tail cut in females, uncut in males: the tip reaching the ground and the wool trailing.

Wool—white, close to the touch—'fills the hand well'—good quality, pretty free from 'kemps', long, but not curled. Clip, 5 to 6 lb. ewes, 6 to 7 lb. hoggs. 'Worsthorne Wonder' as a shearling clipped 17 lb.

Weight Average.—Lambs 10 lb., ewes 16 to 17 lb., wethers 18 lb. per quarter. 'Worsthorne Wonder' weighed 340 lb. when fifteen months old.

Average Price.—Ewe lambs, 30*s.*; ram lambs, 50*s.*; ewes, 42*s.*; wethers, 30*s.* The price paid for rams ranges from £5 to £10; they have been sold for £12, and Hague refused £30 for 'Worsthorne Wonder'.

Wool was 1*s.* 2*d.* per lb. in 1907 and 10*d.* in 1908, and mutton sold at from 8*d.* to 10*d.* per lb.

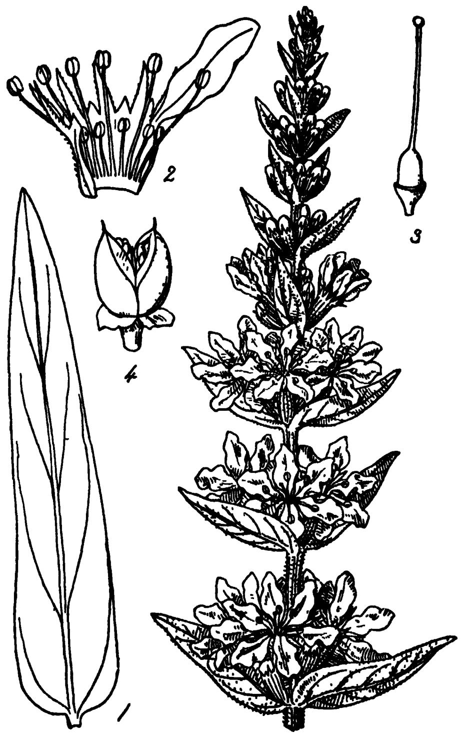
On the whole they are slow to come to maturity, but kill with an abundance of lean meat, and are consequently well suited for crossing. The rams have been used to cross Blackfaced ewes, but the resulting sheep were not able to stand the same vicissitudes of climate as the pure-bred Blackface. The progeny of a Hampshire ram and Lonk ewes do well in the Midlands, and some farmers are having good results with Lonk ewes crossed with a Wensleydale ram, while others use an Oxford Down ram with advantage. In their home district the Lonks are mostly bred pure.

Management of a Flock.—During the winter months the sheep are usually brought down from the hills to the enclosed fields and, should snow come, are given a little hay. Some flocks are sent during November to Cheshire and Derbyshire to winter, at a charge of about 6*s.* per head. The ewes return about the first week in March, and begin to lamb about the third week; they are fairly prolific and are good milkers. When lambing time arrives the ewes are trough-fed for a few weeks to help the flow of milk until the grass comes. The lambs are taken off in August or beginning of September, and the ewes returned to the rough pasture. The rams are sold at the fairs held in September and early October, and are turned to the ewes about the second or third week in the latter month. In breeding pedigree stock, two-shear sheep are generally used, with good large frames but not coarse; size and quality are particularly sought for in selecting a ram. The best lambs, along with the older sheep required for show purposes, are trough-fed during the summer months, and in winter are housed and given swedes, corn, cake, and plenty of good sweet meadow hay. 'In-breeding' is not resorted to for improvement. [T. M.]

Loopers.—This term is applied to the larvæ of a large group of Lepidoptera or moths, *i.e.* the Geometers, which are named from the peculiar manner of progression of the larvæ, which gives the appearance of measuring the ground over which they walk. These larvæ have no legs on the middle portion of the body, but on the three segments following the head there are three pairs, and at the caudal extremity of the body may be found two, three, or four pairs of legs. Owing to the absence of legs on the middle portion of the body we find that the larvæ, when walking, must bring up the caudal portion towards the thorax, which causes it to form an inverted U shape, or loop, from which the larva takes its name of looper, Geometer or earth measurer. When the tail portion has got fixed the larva stretches out its head until the body is straight, and when the thoracic legs are fixed the anal portion is drawn up again. Good examples of this type of caterpillar are to be found in the larvæ of the Common Magpie Moth, which is so common on the currant or gooseberry; the various species of Hybernia or winter moths. The perfect insects are remarkable for their very ample wings as compared with the slender body, and in many species the antennæ of the males are often of complex structure. [J. J. F. X. K.]

Loose Box.—This is a separate enclosure placed either at the end of a stable, isolated from it, or forming a distinct house by itself, and used for the purpose of affording an animal, whether horse or cattle 'beast', more freedom of movement than it can get when stalled. One or more places of the sort are essential at a homestead. A mare approaching her time of parturition needs to be isolated; and a sick or maimed animal is obviously at an advantage when separated from its fellows. But over and above the loose box meant to serve as a casual ward of this description, others in which young horses and odd cattle can be accommodated are acceptable adjuncts at the homestead. The former class are best situated when well apart from stable and cattlehouses. The patients they provide for are then comparatively cut off from contact with the rest of the live stock, which is of great advantage if any contagious malady is in question. As regards the other class, however, on account of both cattle and horses, when well, being fond of each other's company, they may be placed wherever convenient in respect of proximity to either byre or stable. The ideal loose box is dry, airy without being draughty, and sufficiently lighted. A floor space 14 ft. square allows fair room for a horse, a bullock, or a cow; for a pair of young horses or cattle either. An impervious floor is a necessity if the place is to be maintained in a sanitary condition, and effective drainage must be close at hand outside to dispose of the liquid emanations therefrom. At some homesteads there are ranges of loose boxes under one roof and separated by sparred divisions only, for the accommodation of cattle being fattened. These vary in size from room for a pair to space that will hold half a dozen. They are constructed in such a way that there is depth enough in

the box for the season's accumulating manure to be left undisturbed until the cattle have been finished off. Again, there are the class of loose boxes we see wherever horse breeding or training is gone into extensively. These often occupy two or three sides of a square into which the inmates are at liberty to pry over the closed half-doors of their respective boxes. [R. H.]



Purple Loosestrife

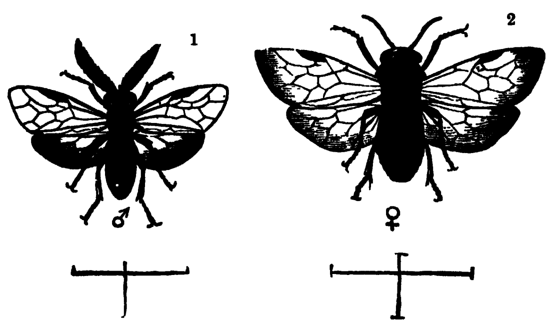
1, Lower leaf. 2, Inside of calyx with one petal left. 3, Pistil. 4, Capsule.

Loosestrife, or **Purple Loosestrife** (*Lythrum Salicaria*), is a typical representative of the dicotyledonous order Lythraceæ. The most characteristic feature is the arrangement of the parts in sixes: 6 sepals grown together and forming a tube, 6 petals not grown together and inserted on the sepals, 6 + 6 stamens; the carpels, however, are reduced to 2, and form a two-chambered ovary containing many ovules. Loosestrife is a tall and handsome perennial herb, with a creeping underground stem, from which the air stems rise to a height of 3 or 4 ft. These air stems are branched and angular, with opposite lance-shaped leaves 3 or 4 in. long, acute at the apex, and heart-shaped at the base. At the end of the stem are leafy spikes of purple flowers arranged in dense whorls. These flowers appear from July to September, and each is about 1 in. in diameter. This plant is common in Britain, and often occupies large space in marshy meadows; at times it fills the ditches or lines the sides of watercourses. In such localities the Loosestrife is so abundant and so conspicuous that it marks the whole landscape with its purple tint. If individual plants are examined they can be reduced to three sets. One set of individuals have long styles, a second set have styles of medium length, and a third set have short styles. This biological peculiarity bears the special name trimorphism, and is a device for securing cross pollination. [A. N. M'A.]

Lop and Top include all the small portions of a tree not sold as timber. What is classed as 'timber' varies locally throughout the British Isles; but this usually includes the trunk and all branches down to 6 in. diameter (free of bark) for broad-leaved trees, and down to 3 in. for conifers; and the rest of the tree, consisting of branchwood and ends, forms the 'lop and top', for which the buyer pays nothing. He is free to take it or to leave it, just as he likes; and if there be any market for fuel, of course it is then fagoted and sold. This curious custom about lop and top was originally a sort of contribution on the seller's part towards the expense of felling and logging the tree, somewhat in the same manner as the customary British 'square-of-quarter girth' measurement of timber in the log (giving 21½ per cent below the actual cubic contents) was intended to allow for wastage in converting. [J. N.]

Lophyrus pini (the Pine Sawfly) is one of the most serious pests of the Scotch Pine. The caterpillar-like larvæ feed on the needles, and the attack has a very characteristic appearance due to the midribs of the needles often being left undevoured. In a bad attack the trees are entirely defoliated.

The sawflies appear twice in the year, in April or May, and in July or August. The females, which fly little if at all, pierce the needles with their saws, and insert eggs which hatch in about three weeks into 'caterpillars', which immediately begin to feed on the needles. When fully fed they measure ·1 in. in length. They then enclose themselves in strong brown cocoons which, in the case of the first brood, are attached to the needles or to the bark of the stem; but in the case of the second brood they are hidden in the moss at the foot of the trees.



Pine Sawfly (*Lophyrus pini*)

1, Male. 2, Female. The lines show the natural size.

The larvæ may be shaken down and destroyed, and many of the flies may be caught by the use of tarred boards. The cocoons may be collected in large numbers beneath the trees, or they may be buried by ploughing up the ground. Pigs admitted in September, when the larvæ come down to pupate, will eat the larvæ and crush many of the cocoons. Insectivorous birds should be encouraged. [C. W.]

Lopping or **Pollarding,** in olden times called 'shredding', consists in cutting off small branches close to the stem and utilizing them as withes or for fuel, &c. It may be practised with any kind of tree having a strong reproductive capacity; but its use in Britain is chiefly confined to Willows (and especially the common White or Huntingdon Willow) growing near the edges of streams in meadows, and on the Continent is mainly confined to the black Italian Poplar planted in rows along country roads, and to Lime trees in central Europe. In pollarding Willows the stem is lopped off or cut through at about 10 to 15 ft. above the ground, and the cutting of the withes every two or three years soon gives the poll a club-like swollen look. In pollarding Poplars the branches are sometimes cut off close to the stem, or else short branch-snags are left, and in the latter case each of these serves as a centre from which clusters of branch-shoots are flushed. Oak, Beech, Hornbeam, &c., used to be pollarded in the English royal forests to furnish browse-wood for the deer and to satisfy the demands of right-holders; and the ill effect of this is still to be plainly seen, for example, in Epping Forest, near London. Many of the largest Oak trees in England are pollards, and it is probably due to this having spoiled them for navy timber that they were not felled when Oak for shipbuilding was very scarce. [J. N.]

Loquat (*Eriobotrya japonica*, nat. ord. Rosaceæ), a native of China and Japan, closely allied to the medlar; cultivated in the subtropics for its small, orange-coloured, apple-shaped fruits. These are sometimes produced in the south of England, but they are inferior, and the Loquat is of no consequence as a fruit tree in this country. Its large handsome leaves and fragrant white flowers make it worthy of cultivation as an ornamental tree in warm situations. It prefers a light soil, and is increased by cuttings, or by grafting on the quince. [W. W.]

Lords and Ladies (*Arum maculatum*) is a corm-bearing perennial monocotyledon plant belonging to the Arum order (Araceæ), found in hedgerows and on damp waysides. The corms and leaves are poisonous. See ARUM MACULATUM.

Lotions.—These are usually solutions for external application to the skin, or for special organs, when they are named eye lotions, ear lotions, &c. Solutions of lead and other poisons which would be altogether prohibited for internal use are with perfect safety applied externally. Sheep dips are really lotions, although the animals are immersed in them; the active principle of the best is arsenic. Some lotions appear to have a specific action on skin diseases; others destroy parasites which give rise to them; evaporating lotions act by producing cold, and others allay pain by their anodyne or sedative properties. Cocaine lotions are dropped into the eye to produce anæsthesia during surgical operations. Parasiticide lotions are poured into the ear to destroy mites (symbiotes) which cause canker, and oily lotions to supply a want of unctuous material. The use of lotions for animals does not differ materially from that of human patients, with the important exception to be always borne in mind, that animals disposed to lick themselves or others must not receive poisonous applications, and that carbolic acid is liable to absorption when used upon dogs and cats. [H. L.]

Lotus is the botanical name for the genus of leguminous plants to which Bird's-foot Trefoil belongs. This genus is most readily distinguished by the characteristic leaf. There is no petiole and no stipules; the whole leaf is reduced to a blade composed of a midrib with three leaflets at its apex and two leaflets at its base. The pair of basal leaflets are usually confounded with stipules. See BIRD'S-FOOT TREFOIL. [A. N. M'A.]

Loudon, John Claudius (1783–1843).—In the art of landscape gardening, Scotsmen have always maintained a high repute for superiority of design and skill in execution; and among those whose work in this domain has contributed in years gone by to the beauty and amenity of country seats and the environments of the large towns of Britain, the name of John Claudius Loudon stands pre-eminent. This may be said to have constituted his main sphere of activity; but, as will be evinced from his writings, he was also an enthusiastic worker in all matters pertaining to the welfare of the rural population.

His life is remarkable for the unswerving perseverance and unflinching toil displayed against physical infirmity and financial distress. The son of a Lanarkshire farmer, he was sent at an early age to an uncle in Edinburgh in order to be educated there. His studies were varied, comprising Latin, French, Italian, drawing and sketching, botany, chemistry, &c. At the age of fourteen he was apprenticed to a nurseryman and landscape gardener, but continued his studies in his spare time, thus adding to his knowledge of current science, and gaining a proficiency in Continental languages which afterwards proved invaluable to him. In 1803 he went to London, and in the same year published his first essay, Observations on the Laying out of Public Squares. In 1806 he was elected a Fellow of the Linnean Society. Unfortunately in the same year he contracted rheumatic fever, which resulted in anchylosis of the knee and a shortened left arm. During his convalescence in the country he had abundant opportunity of observing English farming methods, and satisfied himself of their inferiority to the system pursued in his native shire. So much was he convinced of the possibility of successful farming in England, that he persuaded his father to join him in leasing the farm of Wood Hall, near Pinner. His operations were successful, and in 1809 he rented

a larger farm, Tew Park, Oxfordshire, and took farm pupils for instruction. By 1812 he is said to have made a profit of £15,000 from these sources. In that year he gave up farming and spent two years in Continental travel and study, visiting the chief European countries. He returned to Britain to find that his investments had failed, and that his fortune was practically gone. From this time onwards he laboured incessantly to retrieve his fallen fortunes. He continued his work as a consulting expert on landscape gardening, rural architecture, and on the laying out of cemeteries, and at the same time engaged in literary work on a most extensive scale. A list of his more important productions is subjoined. To agriculturists his Encyclopædia of Agriculture, embodying the data accumulated during his Continental travels, is of especial interest, and still continues to be one of the most important and exhaustive works of reference on the history and literature of European agriculture. His works were not a financial success. On the Arboretum et Fruticetum Britannicum alone he incurred a debt of £10,000. During all the years of his herculean labours he suffered more or less from rheumatism, and the loss by amputation of his right arm, and from chronic bronchitis. Fortunately his mental powers and extraordinary intellectual activity were maintained with unabated vigour to the last, and he died in harness. His name is commemorated by a genus Loudonia described by Lindley, and an oil painting by Linnell was presented by subscription to the Linnean Society. The following is a list of his chief works: A Treatise on Forming and Managing Country Residences (1806); Encyclopædia of Gardening (1822); Encyclopædia of Agriculture (1825); Encyclopædia of Plants (1829); Gardeners' Magazine (begun 1825); Magazine of Natural History (begun 1828); Encyclopædia of Cottage, Farm, and Villa Architecture (1832); Arboretum et Fruticetum Britannicum (begun in 1833, completed in 1838, in 8 vols.). [J. B.]

Louping Ill or **Leaping Ill** (*Chorea paralytica ovis*), a disease of the sheep, characterized by nervous spasms of the limbs and neck, and for this reason known in some districts as 'trembling'. The symptoms, however, are not constant, for while some animals exhibit distinct nervous spasms of the limbs, causing a peculiar staggering gait, followed by inability to rise, and eventually death, others again are in a dazed condition throughout, and speedily collapse. These different symptoms may be seen in sheep grazing on the same ground, and it is therefore concluded that it occurs in two forms, viz. acute and chronic, but this very probably can be explained by the degree of susceptibility existing in the individual animal.

So far as is at present known, the disease seems to be confined to the British Isles, and to be very prevalent in the west and south of Scotland and the north of England, especially Northumberland. The annual loss to flockmasters due to louping ill is very considerable, for the mortality varies from 3 per cent in the more favoured districts to 20 per cent, or more, in the worst localities—indeed the writer knows of one holding where the tenant was wellnigh ruined because of a mortality of over 30 per cent. A particularly high death rate occurs when sheep have been moved from 'clean' or non-infected ground on to 'foul' or infected pasture. The dividing line between 'foul' and 'clean' pasture may be very sharply drawn, as a fence or small stream is in many instances the limitation of the infected ground. This sudden and unexpected sharp definition of an infected area was for long difficult to explain, but the more recent pathology of the disease would seem to offer the solution. Owing to the fact that veterinary surgeons are rarely consulted with regard to sheep diseases, the knowledge of their pathology is not so full as is the case with diseases common to the various farm animals; but since louping ill claims such a heavy toll, investigation regarding its etiology and pathology has been undertaken by various authorities for more than a quarter of a century. In this respect much useful work has been done by M'Fadyean, Klein, and Williams; and mainly on the representation of the Duke of Northumberland, the Board of Agriculture appointed a Departmental Committee, with the late Professor Hamilton as its chairman and bacteriologist, to investigate louping ill and another sheep disease, braxy. The appointment was made on the 12th December, 1901, and after a very large amount of work an official report was published on the 10th April, 1906. At the first meeting of the Committee a line of action was adopted, and it was resolved: first, to have a large number of affected animals under strict observation to obtain reliable knowledge of the symptomatology and pathology of the disease; and second, having obtained that knowledge, to devise and recommend some preventive measures.

Louping ill is usually associated with sheep, and is a disease to which they are subject at all ages, but more especially during their first year. It must be known, however, that cattle and pigs are also occasionally attacked. The importance of this point is apparent when considering the infection of the pasture.

The symptoms presented to the farmer or shepherd who does not have the affected animal under prolonged observation are often misleading, and the term 'louping ill' therefore comes to be somewhat loosely used. An abscess pressing on the spinal cord—by no means uncommon in lambs—produces symptoms almost identical with those of louping ill. In older sheep a form of anæmia—known to shepherds as 'blood-rot'—produces weakness and staggering which may also be mistaken. Black-quarter and anthrax in sheep also lead to mistakes, although these two diseases more closely simulate braxy. The difficulty of diagnosis is naturally much increased when the shepherd finds a sheep dead and he has had no opportunity of observing its behaviour while alive.

As before stated, the disease may run an acute or chronic course, and perhaps the chronic form is the better known. At first the sheep seems to have lost the power of co-ordination of the muscles, and staggering, with an occasional

fall, ensues. This is usually followed by convulsions, and afterwards the animal becomes more or less paralysed, lying sometimes for weeks unable to rise. The appetite, until near the end, remains good, and the sheep will eat all the grass within its reach, making convulsive efforts to obtain more, and if offered food from the hand will partake freely. Partly owing to the endeavours to obtain food, but probably more to pain, in many cases there is observed a peculiar 'galloping' movement of the limbs which is kept up for hours, leaving very distinct marks on the ground. If the animal is fed and given water or milk there will be an occasional recovery, but one or more of the limbs, or perhaps the neck, may be permanently crippled. In the acute cases the sheep is found dead, or, if alive, dies in a few hours, showing symptoms of complete collapse only.

The difficulty in determining the pathology of the disease by post-mortem examination was the absence of any specific signs of disease in the various internal organs. For this reason it was presumed, and is still believed by many, that the tick was the carrier of the virulent material, after the manner of the mosquito in malaria of man. The blood, however, is free from any organism, and all inoculations made with it fails to convey the disease from one sheep to another.

Post-mortem examinations made on a large number of sheep revealed the fact that in the majority there was an excess of liquid in the peritoneal cavity—the cavity formed by the walls of the abdomen and containing the intestines. Microscopical examination of this fluid shows that while at times it is apparently free from any organism, at others it literally swarms with a somewhat large rod or bacillus. When the bacilli occur in large numbers the liquid is always plentiful and of a mud-red colour, but when the organisms are scanty the fluid is clear. It would seem, therefore, that it is the number of germs present which render the liquid turbid; and this has been proved by incubating some of the clear fluid in a tube for twenty-four hours, when, because of the rapid and prolific propagation of the bacillus, the liquid becomes quite dark-coloured. Not only so, but if this incubated material be inoculated subcutaneously into a healthy sheep the animal usually dies within a few hours, showing all the symptoms of an acute case of louping ill. If this bacillus is the actual cause of louping ill, by what means did it reach the peritoneal fluid, and why is the fluid clear and germ-free or nearly so in some cases—chronic—while in others turbid and germ-laden—acute?

Professor Hamilton declared that this organism can be found in the contents of the intestines of healthy sheep which have been grazing on infected pasture, and if this be true it is easy to understand how ground can become foul. The bacteria or their spores—which latter are much more tenacious of life—are in the ground or on the pasture, and are taken up by the mouth when feeding, and thus pass into the alimentary canal. Here they remain and multiply, being evacuated in quantities with the dejecta, but not necessarily infecting the animal. This frequently happens in anthrax, but in this case the spores did not gain the blood circulation because throughout the whole alimentary tract there was no wound to allow of their entrance. The pathological conditions of the two diseases are not, however, similar, since anthrax is essentially a blood disease, whereas in louping ill the blood is always unaffected. The pathogenicity, or the power to produce disease, of the two organisms is also dissimilar, as there are no chronic cases of anthrax.

The explanation is found in the fact that louping ill is a seasonal disease, *i.e.* it appears only at certain seasons of the year, viz. at the back end of the year and in spring. Climatic influences and feeding are responsible for this—not on the organism or ground, but on the sheep. It was found that if the blood of a healthy sheep were placed in a test tube, a culture of louping-ill bacillus added to it, and the mixture incubated at the body temperature with exclusion of air, very opposite results were obtained at the different seasons of the year. If this were done during the louping-ill season the organism grew freely in the blood, while at other times of the year the converse took place—the blood destroyed the bacillus. Thus during certain months of the year the bacillus may apparently reside and multiply in the alimentary canal without occasioning any injury to the sheep. The walls of the intestines form a complete barrier to its passage into the peritoneal cavity because of the blood exerting an influence inimical to its life. When the dangerous period—the back end and the springtime—approaches, owing to the blood failing in its power to destroy the bacillus this protective influence is lost, and the organism, if now picked up by the sheep for the first time, is able to pass the wall of the intestine with facility. If such be the case, the growth in the peritoneal liquid will be luxuriant, the liquid turbid because of the number of bacilli present, and the sheep will die showing all the symptoms of an acute case of louping ill. This is the explanation of the question of susceptibility and immunity, but it can be understood there must be a number of cases where the blood does not exert its influence in either direction so powerfully as to make the rule invariable. Indeed it would seem in the chronic cases, where the animal lingers for a considerable period and exhibits the 'galloping' symptoms before referred to, the power of the blood to destroy the bacillus is not completely lost, and the invasion of the peritoneal cavity is much more gradual. A condition of chronic poisoning is then established, the poison acting slowly on the nerve centres and paralysing them. It is in this type of the disease that the peritoneal fluid is clear, and the bacilli usually unrecognizable under the microscope until their numbers have multiplied by incubation.

From this it is concluded that sheep which pick up the germ during the season when they are not susceptible, *i.e.* when the blood has the power to destroy it, allow of its passage along

the intestine without becoming affected, and are thus evidently rendered immune, so that when the louping-ill season arrives they fail to contract the disease. On the other hand, sheep which ingest the spores during the dangerous period, *i.e.* when the blood favours the growth of the organism, have little power to resist the passage of the bacteria into the peritoneal cavity, and consequently fall victims to the disease.

If this theory be correct it explains the high death rate in lambs and hoggs, and the still higher mortality in sheep brought from 'clean' to 'foul' pasture during the louping-ill seasons.

This assumption could be proved, to a certain extent, by administering to the sheep at a fixed time of the year, before the advent of the dangerous period, a carefully prepared medium containing the bacillus, and on this line a method of preventive treatment was recommended.

The drench is prepared by incubating the specific organism in glucose-beef tea, and after adding a small quantity of water, is given to the sheep by the mouth, a second dose being given a week or a fortnight later.

The sheep so drenched show no pain, no symptoms of the disease, and, what is of importance, no loss of condition; but great care must be taken to dose them at the correct period of the year, for if it be done at a time when the animals are susceptible they will contract the disease and probably die.

In the hands of the members of the Committee the first application of this preventive treatment was followed by numerous failures, largely owing to the ignorance of the seasonal variation of the blood; but later on, when this was more definitely fixed, the success was more apparent. From 1903 to 1906 the treatment was employed, and a very large number of animals subjected to the test. In the last year, over 15,000 were employed; and although the success was not absolute, the measure was such as to warrant the belief that the treatment is on the right lines; and as the knowledge of the pathology of the disease is added to, and perhaps the drench improved, it is not too much to expect that the solution of the problem will be found.

As in all diseases of man or animal, absolute immunity cannot be expected; but if the simple method of drenching the sheep at a fixed period with a specially prepared medium will reduce the mortality to an ordinary trade risk, much benefit will be conferred on the flockmaster.

But the stock-owner and shepherd must remember that a dead sheep can infect or 'foul' the ground by the liquids containing the organisms escaping; and thus the prevailing method of skinning a fallen sheep and casually disposing of the carcass is fraught with danger.

If by burying the carcass intact the loss from louping ill—or in fact any other disease—can be reduced, surely it is worth the sacrifice of a few skins per year. Also the carcass is to be disposed of at once, as it has been proved that flesh-eating animals—dogs, carrion crows, &c.—themselves immune to the diseases, can carry the bacilli or spores in their intestines and scatter them broadcast over a wide extent of country.

The lamented death of Professor Hamilton put a stop to the preventive experiments; but as all the data are available it is hoped they will be taken up again and, with the hearty co-operation of sheep-owners, carried to a successful issue. [J. M'L. Y.]

Louse.—The lice form a small group of the insects called the Anoplura, composed of small species with very thin body covering. The head, thorax, and abdomen are well marked, although the divisions of the thorax are scarcely separate. The mouth parts consist of a short tube provided with hooks, and when the insect is in the act of feeding it can protrude a very fine sucking tube. The legs each bear a long claw, and none of the species are provided with wings.

These insects are parasitic on various species of birds and mammals. Three species are attached to man; while horses, monkeys, elephants, seals, and whales have others. These disgusting insects are very prolific, and their existence is helped by neglectful and dirty habits. For methods of extermination, the reader should consult the article LOUSINESS.

[J. J. F. X. K.]

Lousewort (Pedicularis) is a genus of herbaceous dicotyledonous plants belonging, like

Pasture Lousewort

1, Corolla opened out. 2, Calyx opened out.

the foxglove, to the nat. ord. Scrophulariaceæ. These plants grow only in bogs and marshes, in pastures which are so wet that they can scarcely be expected to produce nourishing food for stock. Besides, the grasses associated with Lousewort are liable to be diseased, for the roots of the Lousewort attack and prey upon the under-

ground parts of the grasses in their neighbourhood. Lousewort is thus a *partial root parasite.* Furthermore the parasite itself is suspected as a poisonous plant; hence stock reared under the conditions described can hardly be in good health, and are in fact often infested by lice. There is a whole tribe of Scrophulariaceous plants which are partial root parasites on grasses, and all of them become quite black when they are made into hay. The two common species of Lousewort are: (1) Pasture Louse wort (*Pedicularis sylvatica*); (2) Marsh Lousewort, or Red Rattle (*Pedicularis palustris*).

Pasture Lousewort is a perennial with a very short underground stem serving as a stock, from which many air stems branch out. These air stems seldom rise above 6 in., and bear alternate leaves, composed of many cut segments arranged along a midrib. About the month of June, spikes of rose-coloured, sometimes nearly white, flowers appear at the end of the stems. Later, the plant is in fruit, and now bears flat capsules with a few large seeds attached to the lower part of the seedcase.

Marsh Lousewort is an annual with a taproot from which a single erect stem rises into the air to a height of 1 or 2 ft. Leaves and branches are produced along the sides of the air stem, and terminal spikes of flowers. These flowers have a dull-crimson colour, and on each side of the compressed upper lip of the corolla, halfway down, there is a projecting tooth. These teeth are absent from the upper lip of the corolla of Pasture Lousewort. This species is rejected by stock, but young plants of Pasture Lousewort are sometimes sparingly eaten. [A. N. M'A.]

Lousiness.—Phthiriasis, or lousiness, induces itching, rubbing, or scratching, restlessness, and ill thriving among all species of animals, and is therefore a source of discomfort to them, and of loss to their owners. The parasites are of two kinds—those which puncture the skin in order to obtain the blood upon which they live (see Hæmatopinus), and those which are not provided with the necessary armature, but derive their food from the desquamating products of the integument (Trichodectes). Both varieties may be found upon the same animal. Lice have a preference for the very young, and for others in poor condition, poverty and lice being frequently associated. Animals yarded with barley straw or bedded upon it are observed to suffer from lice more than others. In order to destroy them we must bear in mind the comparative immunity of the ova to dressings which kill the adults. Hence to guard against the possibility of those ova, which remain uninjured by the first application, hatching out and reaching sexual maturity, we should repeat the remedy in about a week's time. Any rancid butter, fat, or cheap oil will kill lice by stopping up their breathing pores; discoloured cod-liver oil unfit for other purposes may often be obtained at a low price. Where large numbers of animals with winter coats have to be dealt with, it will be cheaper to make a decoction of stavesacre and tobacco with which to dress them. One part by weight of the seeds to 30 of water, boiled for an hour, and fortified by 1 part in 60 of common shag or of non-dutiable tobacco juice, is effectual. If only limited areas are affected, mercurial ointment may be judiciously employed when the season is too cold for aqueous applications. [H. L.]

Low, David (1786–1859), a professor of agriculture, and author of the agricultural classic, The Breeds of the Domestic Animals of the British Islands. As a young man he assisted his father for several years in his profession of land agent, and gained considerable repute as a farm and estate valuer. He made his first notable contribution to literature in 1817, viz. Observations on the Present State of Landed Property and on the Prospects of the Landholder and Farmer. He settled in Edinburgh in 1825, and in the following year the Quarterly Journal of Agriculture was established at his suggestion. Of this journal he was editor during the years 1828–1832. In 1831 he succeeded Professor Andrew Coventry as professor of agriculture in Edinburgh University. Shortly after his appointment he took steps to institute an agricultural museum. For this purpose he obtained a Government grant of £300 per annum, which was largely expended in procuring portraits of notable animals of the leading breeds of stock. Many of these paintings were subsequently used as colour illustrations in his splendid work, The Breeds of Domestic Animals of the British Isles, which made its first appearance in 1842. He resigned the Chair in 1854. In addition to those above referred to, Professor Low was the writer of other two books which are worthy of mention, viz. (1) The Elements of Practical Agriculture (1834), and (2) On Landed Property and the Economy of Estates (1844). [J. B.]

Lowland Breeds of Sheep. — These comprise most of the long-woolled, white-featured, and heavier breeds (see Long-woolled Sheep), and include several modern races, among which may be mentioned the Oxford, Shropshire, and Suffolk sheep, which are dark-faced. A precise definition is impossible, as some are bred on hills and fattened on lowlands, while others are found on both hills and vales. If classed together as lowland sheep they will be found to include many half-breeds, such as the well-known cross between Cheviots and Border Leicesters which are widely scattered over the lowlands of Scotland and the northern counties of England. If we review the distribution of sheep throughout Great Britain we shall find the above half-breeds occupying a very important position. So also what are known as mules or Masham sheep are favourites upon lowland farms of poorer character. Half-bred sheep, produced by the union of Hampshire, Shropshire, or Oxford sires and long-woolled dams, are very generally distributed over many flat districts, and are well adapted for fattening on turnips. On the other hand, there are intermediate districts of undulating character, such as the heaths and wolds of Lincolnshire, on which Lincoln and Leicester sheep are maintained in various degrees of purity. So far as distinctly lowland proclivities go, the true long-woolled races and the pure-bred Leicester can-

not be excluded, while the Cheviot is sometimes found far below his native heights. The true hill sheep is, however, impatient of confinement, and is apt to overleap hurdles, ruts, and even wire fences. Their active character is inconsistent with the tamer surroundings of the lower lands, and a cross with heavier and more domesticated breeds is often necessary to produce a lowland sheep. Confinement between hurdles, turnip feeding, and artificial feeding do much to produce a lowland type, and when removed from open downs and semi-mountainous regions many hill sheep settle down to the lazier habits of the heavier breeds, which are naturally suited for cultivated tracts. The true lowland sheep is of an indolent and quiet nature, as illustrated in Leicesters and Lincolns, or in the Cheviot-Leicesters already mentioned. The Suffolk sheep has been included among lowland breeds, and if this is allowed it is difficult to see why Southdowns should not also be similarly classed. Hampshire sheep, although bred upon the high-lying downs of the chalk, are very patient under confinement, and are accustomed to be restrained between hurdles, and to be folded on arable land. They are thoroughly well adapted for a lowland life, as also are the Cotswold sheep, which are bred on the high plateau or tableland of Cotswold. There seems, in fact, no reason to exclude any breed which may be and is kept in large numbers upon arable land, and the best distinction between what may be called Lowland and Highland sheep is the suitability of the former for winter and summer grazing on the flatter descriptions of soil. [J. WR.]

Lubricants have become of greater importance on the farm by reason of the more extended use of machinery. Until recent years, cart grease and common machine oil sufficed for the simple machines and implements in use; but since high-speed machines, such as milk separators and oil motors, have come into general use, a far wider range of oils has to be provided. Cart grease is still suitable for carts and wagons with common axles, for plough wheels, and the like; but even many of the simple implements are made with better bearings, which adapt them to the use of oil. Oils are obtained from many sources—animal, vegetable, and mineral. Sperm, tallow, and lard are examples of animal oils, and olive or rape of vegetable. Oils suitable for one class of work are not necessarily adapted for others. Where heavy pressure has to be met, oils with good body are required. Sperm oil is an excellent lubricant, but not satisfactory for high temperatures. Vegetable oils deteriorate rapidly in use because they volatilize readily under heat. Oils differ greatly in their cost, for while the ordinary dark lubricant used for threshing-machine drums and ordinary agricultural machinery costs 1*s.* 3*d.* per gal., a well-prepared separator oil suitable for very high speed in small bearings might cost 3*s.*, a suitable gas-engine oil 2*s.* 6*d.*, a highly refined cylinder oil 2*s.* 3*d.*, a heavy-bodied oil suitable for very heavy bearings 2*s.*, a general-purpose oil for portable engines and agricultural machinery 1*s.* 3*d.*, while bench oil would cost 10*d.* All oils should be free from acid, which has ill effects on bearings; oils should not clog or gum, but always keep the bearings clean and cool. [W. J. M.]

Lucanium cervus, or the Stag Beetle, one of the largest British beetles, belongs to the family of the Cockchafers, and in habit resembles the common cockchafer (see MELOLONTHA VULGARIS). The larva is very like that of the latter insect, but it attains a larger size, and is easily distinguished from it by the fact that the anal aperture is placed transversely and not longitudinally as in the case of the cockchafer larva. It lives in decaying wood and eats away the roots of trees. The larval stage lasts for about four years, but the pupal stage is rapidly passed through. The perfect insect remains some months underground before it becomes active—which usually takes place in midsummer.

Lucerne.—Lucerne (*Medicago sativa*, L.) belongs to the nat. ord. Leguminosæ and is included in the Medick genus, being sometimes known as Purple Medick. It grows wild in several parts of West and Central Asia, and was cultivated by the ancient Greeks, Romans, and Persians. In Spain and America, where it is extensively grown, it is commonly known by the Arabic name Alfalfa.

Common Lucerne (*Medicago sativa*)

In hot climates Lucerne is one of the most important forage plants, resisting droughts which dry out most other green crops, and giving several cuttings of nutritious fodder per annum when well established.

It is a perennial with a very extensive and deep root system. Where the soil is open and the subsoil disintegrated or fissured, the roots descend many feet, and are able to draw on supplies of water which are rarely reached by ordinary farm plants.

From the thick rootstock, which may remain active for twenty years or more, a number of erect stems are sent up to a height of 1 or 2 ft.

The leaves are alternate, trifoliate, with narrow obovate leaflets, having dentate margins and projecting apex to the midrib.

The flowers are produced in dense racemes which arise in the axils of the leaves; the corolla is of the usual papilionaceous form, purple or sometimes a pale creamy or buff yellow.

The fruit is a spirally twisted pod containing several greenish-yellow kidney-shaped seeds about the size of Red Clover seeds, and resembling those of its near relative Yellow Trefoil or Black Medick (*Medicago lupulina*, L.).

For the proper ripening of seed a warm climate is necessary, the best European seed being produced in the Provence region in France.

No well-marked morphological varieties of Lucerne are known, but physiological variation occurs. A form, known as Turkestan Alfalfa, introduced from the arid parts of Central Asia, appears to be more adapted for cultivation on the arid alkali lands in the United States and Argentina than the ordinary variety. Arabian and Peruvian varieties are capable of yielding very large crops over a long growing season, but can only be utilized in districts with mild winters, as they are easily killed by frost.

[J. P.]

Lucerne, or Alfalfa (*Medicago sativa*), is one of the most valuable of our forage plants. Its adaptability to climates having wide variations in temperature, its moderate demands upon the soil for nitrogen, and its large cropping powers and high feeding value, stamp it as a forage plant of the highest importance to the farmer.

Lucerne is a plant which has been well known and cultivated for more than two thousand years. It was introduced into Greece during the Persian wars. The Moors brought the plant to Spain under the name of Alfalfa, and the Spaniards subsequently took it to Mexico during the time of the Spanish invasion, and since that time it has spread over the greater part of South America, the United States, and Canada, where it is now known as Alfalfa. In Europe Lucerne is cultivated extensively in France and Germany; and though it has been grown in Britain for a long time, still it does not appear to have received the amount of attention from the British farmer that its great utility seems to demand. That the crop is coming more into favour is indicated by the recent Returns of the Board of Agriculture, which show that the acreage grown in England is decidedly on the increase.

	Acreage of Lucerne, 1907.	Increase over 1906.
England	63,379	7974
Wales	338	54
Scotland	78	33
Total increase in Britain		8061

Out of the total area of Lucerne grown in England,

Essex produces	16,644 ac.
Kent ,,	11,586 ,,
Suffolk ,,	5,465 ,,
Total	33,695 ,,

That is, more than half the area grown in England is produced in the three counties named above.

The following table, compiled from the Returns of the Board of Agriculture and Fisheries for 1907, shows the acreage of Lucerne grown in some of the principal Lucerne-growing countries for which statistics are available:—

Country.	Acreage.	Year.
Argentina	4,273,503	1902–3
Belgium	33,049	1905
France	2,657,923	1905
Germany	594,872	1906
Russia in Europe, including Poland	130,291	1901
Australia	108,404	1905–6

Very large areas of Lucerne are grown in the United States of America and in Canada, but separate statistics as to acreage do not appear to be published.

There appears to be a fairly general opinion that Lucerne is a plant only suited for hot, or at least warm, climates and mild winters with little or no frost. That such an opinion is not well founded is plainly proved by the fact that it is grown with excellent results in all the leading agricultural provinces in Canada, where the summers are hot and dry and the winters sometimes very severe, the thermometer frequently falling many degrees below zero. Lucerne will withstand a severe climate provided it is grown on a deep, well-drained soil, but quickly loses root and dies away on a waterlogged soil, even in a mild climate.

Varieties.—There are several varieties of Lucerne, but the one most commonly cultivated for forage is the one having purple flowers, sometimes known as Purple Medick. It has a stout stem which stands erect, and under ordinary conditions is not liable to lodge. As the plant approaches maturity the stem is inclined to become woody, and this fibrous nature increases very greatly when nearing the flowering stage, and for this reason it is of the utmost importance that the crop be cut before the blossoms are out. The stem carries an abundance of leaves, which are very nutritious. If the plant is allowed to flower before cutting, the lower leaves die and fall away, thus causing considerable loss in food substances; hence we have another important reason for cutting Lucerne when young.

The root system is one of the most striking features of the plant; the roots in a very short time penetrate to enormous depths. In the autumn of 1907 an eighteen-months-old plant was dug from a clay loam soil (subsoil clay), and the roots at a depth of 21 in. were as thick as whipcord. On soils resting on porous subsoils it is not uncommon for the Lucerne roots in a few years' time to extend to a depth of several feet.

This deep-rooting habit is of immense value; it enables the plant to withstand prolonged droughts, which cause serious injury and some-

times completely burn up ordinary shallow-rooted plants such as White Clover. This power of Lucerne to withstand drought was very strikingly shown in the south of England during the late summer and dry autumn of 1906. The meadows and pastures were in many places completely burnt up, while the Lucerne, though not producing a bulky growth, yet maintained its green healthy appearance throughout the drought. The enormous root range also enables the plant to obtain food substances from the lower parts of the soil and subsoil, where the roots of most plants never gain access. This gives the Lucerne a much greater feeding area than is available to most plants. Thus by having this power to draw upon these distant sources of plant food it gradually fertilizes the surface soil at the expense of the subsoil. Also, when the roots decay humus is added to the soil, and the small channels left by the decayed roots greatly assist in the natural drainage and aeration of the soil and subsoil.

Another characteristic which Lucerne possesses in common with other leguminous plants is the power of utilizing the free nitrogen of the air. This property enables the plant to grow successfully and yield large crops with the aid of very moderate applications of nitrogenous manures, and moreover the soil is enriched by reason of the nitrogen which is accumulated in the soil and crop residues, which, after decomposition and nitrification, become available for the succeeding crops.

Soil Suitable.—Being a deep-rooted plant it is essential that the soil should be deep, so as to allow the Lucerne roots sufficient space in which to ramify. Also, if Lucerne feeds on the nitrogen found in the soil air it is necessary that the soil be thoroughly aerated. Aeration of the soil is impossible if the land is waterlogged. Therefore on such land satisfactory results cannot be obtained, and Lucerne should not on any account be sown until the stagnant water is removed by proper drainage, so that a free circulation of air through the soil may be obtained.

Provided the soil is moderately fertile, fairly deep, and well drained either naturally or artificially, Lucerne will do well on most kinds of soil. A typical suitable soil is a deep calcareous loam containing a good percentage of clay. On the stiff loamy soils containing chalk and flints, 'sometimes found at the base of the South downs', excellent crops are produced, yielding three or four cuts in the season. Excellent crops are also grown on clay soils and clay loams.

On these soils, when well drained and limed, Lucerne grows very luxuriantly, producing splendid crops, which may be taken for six or seven years in succession, easily yielding an average crop of 15 to 20 tons per acre of green fodder, which may be fed direct to farm stock or made into hay.

To produce a crop of Lucerne the seed should be good and free from impurities; it may be sown in spring in April on a corn crop, barley, or oats, or the seed may be sown down in early summer after a spring-fed catch crop. If the latter method is adopted it is a good plan to sow down with about 20 lb. of mustard as a nurse crop, and as soon as the crop is well up, say 4 or 5 in. high, run the grass mower over it. The cutting bar of the machine should be set fairly high so as to take off only the tops of the plants; the swath board should also be removed so as to allow the cuttings to lie evenly over the surface of the land. The cuttings act as a mulching, and in a dry season prevent rapid evaporation of moisture and drying and cracking of the land, thus greatly assisting in the promotion of a uniform and vigorous growth. If the crop does well it will probably produce a fairly bulky growth, which should be grazed down before the middle of September. In grazing, great care should be taken not to overstock or graze too closely, and for this purpose young bullocks are more suitable than sheep. Sheep may be used if they are kept moving and not allowed to bite too closely.

In grazing, the object to be kept in view is the development of a short, strong, sturdy growth before winter, as such a crop withstands the frost infinitely better than a long, soft, sappy growth. In mild seasons the grazing is sometimes extended into October; but this is generally a somewhat risky practice, as the plants may not have time to recover their growth before frost commences, and may be killed.

Methods of Sowing.—The seed may be either drilled or sown broadcast. When drilled, the amount of seed required is from 20 to 25 lb. per acre, and the rows are placed from 9 to 12 in. apart, which allows sufficient space for horse-hoeing and cleaning. The system of drilling is frequently practised, and excellent crops are produced by this method; but the cost of horse-hoeing and cleaning is very expensive, and under suitable conditions the broadcasting is much more economical. When the seed is broadcasted horse-hoeing cannot be practised, hence the necessity to have the land as clean as possible. Sufficient seed should be sown so as to well cover the whole of the land with Lucerne plants, so that there may be as few bare places as possible for weeds to grow. When broadcasted, 25 to 30 lb. of seed per acre will be required.

Under the best conditions Lucerne alone does not form a close bottom, and after a few years' time the crop gets more or less overgrown with weeds. To prevent this, suitable grass seeds should be broadcasted along with the Lucerne; the grasses occupy the spaces between the Lucerne plants, thus taking the place of weeds. Experiments conducted at the Uckfield College Farm for a period of years show that if strong-growing grasses, such as Timothy, Meadow Fescue, Cocksfoot, are sown along with Lucerne, the grasses take the place of and smother out injurious weeds and bad grasses, and at the same time do not interfere with the proper growth and development of the Lucerne. The mixture of seeds which has given the best results is 25 lb. Lucerne, 5 lb. Timothy, 7 lb. Meadow Fescue. This mixture during the past five years has yielded an average of 5 tons of hay per acre per annum.

MANURES FOR LUCERNE.—Owing to the fact that Lucerne is able to make use of the inexhaustible supplies of nitrogen in the atmosphere, it has been erroneously assumed that the application of nitrogenous manures to Lucerne and other similar crops is simply sheer waste of manure, if not positively injurious to the crop. That nitrogenous manure, either in the form of nitrate of soda or sulphate of ammonia, can be very profitably used on either the clovers or Lucerne has been proved repeatedly by various experimenters. With respect to the influence of nitrate of soda on Lucerne, Dr. Bernard Dyer in his experiments at Hadlow has shown that 1 cwt. per acre used in conjunction with phosphates and potash gave during a period of five years an average yearly increase of 2 tons 17 cwt. green fodder over the plot which had phosphates and potash but no nitrate of soda. When the nitrate of soda was increased to 2 cwt. per acre the average yearly increase 'over the phosphates and potash alone' was brought up to 4 tons 11 cwt.

As Lucerne makes large demands upon the soil for phosphates, potash, and lime, these substances should always be present in the soil in sufficient available quantities to ensure a vigorous growth, otherwise applications of nitrate of soda will not be effective. Judging from trials conducted at the Uckfield College Farm extending over a period of five years, the following manures may be safely recommended for Lucerne when grown on clay soils or clay loams:—

Basic slag ...	5 cwt.	applied in winter.
Kainit	2 ,,	
Nitrate of soda	1 ,,	,, April.

On chalky soils basic slag may be replaced by 3 or 4 cwt. superphosphate.

The use of Lucerne in producing nitrogenous food substances for stock and at the same time leaving the soil well stored with nitrogen has been shown in a striking manner by the experiments conducted at Rothamsted, and recorded by Dr. Dyer (Trans. H.A.S., vol. xiv, 1902).

On Hoos field, wheat after bare fallow was compared with an adjoining plot of Lucerne. Neither crop received any nitrogenous manure, and after a period of eight years it was found that the average yearly crop of Lucerne contained more than thirteen times as much nitrogen as the average yearly crop of wheat (straw and grain), thus showing the immense superiority of Lucerne over a grain crop as a producer of nitrogenous food for stock. On an analysis being made of the soil from the two plots it was found that in the top 9 in. of soil the Lucerne plot contained 524 lb. more nitrogen per acre than the plot which had been cropped with wheat. This amount of nitrogen is equal to about 30 cwt. of nitrate of soda, worth £17 to £18. These experiments bring out the wonderful properties of Lucerne as a producer of nitrogenous food for farm stock, and its power as a collector of nitrogenous matter in soils for the use of succeeding crops.

LUCERNE AS GREEN FODDER may be used with advantage for all kinds of farm live stock—horses, cattle, sheep, or pigs.

For horses it may be fed green or as hay. In hot summer weather, green Lucerne is exceedingly valuable for horses. It is succulent, cooling, and at the same time very nourishing. It keeps them in a good healthy working condition, and horses which have a liberal supply feed well and work well, and keep in good condition throughout a trying season, and moreover with a very small allowance of dry corn.

When fed to dairy cows Lucerne should be cut fairly young, as in this stage it is better adapted for cows, as it is more nutritive and digestible. If practised with care, sheep may be allowed to graze the crop, but it causes less waste to cut it and feed it in racks.

Like other leguminous forage crops when fed green, too much Lucerne is liable to cause hoven in sheep and cattle. To avoid this it should be fed sparingly at first, cut when dry, and allowed to wither slightly before giving to stock. When grazed the crop should be dry, and the animals turned on with full stomachs; this is to prevent them eating too greedily until they become accustomed to the change of diet.

For feeding to pigs Lucerne should be cut when quite young and succulent. It may be given fresh cut twice a day, morning and evening, allowing just sufficient for the pigs to clear up easily. As it is very succulent and cooling, Lucerne keeps the animals in good health during hot weather and promotes a good appetite; also being rich in nitrogenous and carbonaceous food substances, only a very moderate addition of dry concentrated food is necessary to keep the pigs in a good thriving condition.

LUCERNE AS HAY forms one of the most suitable and nourishing of the dry fodders for horses, and is used to some considerable extent for feeding to London van and dray horses.

When made into hay the crop is usually cut twice, and the cutting should be done just before the flowers open. By cutting early the stems are not so fibrous and indigestible, and there is less loss of leaves, and the crop grows away more rapidly for the second cut. The aftermath after the second cut may be lightly grazed with young bullocks or sheep.

TO MAKE LUCERNE HAY great care is necessary even in good weather, and the method of handling the crop will vary according to the state of the weather; but the following points have been found in practice to be worthy of careful attention:—

1. Cut the crop after the dew is off.
2. Do not cut more than can be conveniently handled in one day.
3. When the crop is ready to turn, do it carefully with forks while dew is on.
4. Do not allow crop to be scorched in the swath; if so, the leaves shrivel up and fall away when moved.
5. When partially dry, put it up first into small cocks, then into larger cocks, and allow to cure gradually.
6. Never attempt to dry completely in the swath.
7. In all operations handle the crop as carefully as possible.

YIELD PER ACRE.—A good crop of Lucerne

should yield 20 tons of green fodder in the year. This amount fed to dairy cows, allowing 100 lb. per head per day, would be sufficient for four cows during the four months in summer. If made into hay, 20 tons of Lucerne would yield between 4 and 5 tons of hay, according to how the hay was managed in the making; and 5 tons of good Lucerne hay should contain a total amount of nutritious substances equal to what would be found in about 35 cwt. of the best decorticated cotton cake. [W. SOU.]

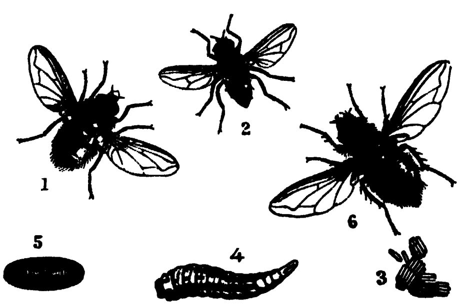
Lucerne.—Parasitic Fungi.—

CROWN GALL AND ROOT ROT.—The perennial crowns frequently become diseased and die away prematurely. In some cases the progress of the disease is very similar to that of clover sickness: the leaves are discoloured and killed by the mycelium of a fungus (*Sclerotinia*), which also forms sclerotia capable of producing ascus-fruits (see art. CLOVER SICKNESS). The name 'lucerne destroyer' is applied in parts of Germany and France to a fungus (*Rhizoctonia violacea*); this destroys the underground parts of lucerne, carrot, beet, and other 'roots', and invests them in a felted violet or brownish mycelium which spreads rapidly through the soil to adjacent plants; no spores are produced. Crown Gall has appeared recently in southern England (Reports, Agric. College, Wye, 1906–7); the crowns bear warted outgrowths, each gall consisting of diseased tissue enclosing cavities filled with the spores of the fungus *Urophlyctis alfalfæ*; within recent years this has proved destructive in several European countries.

LEAF-SPOT AND MILDEW. — Several fungi which attack Clover also occur on Lucerne (see art. CLOVER SICKNESS).

Treatment.—In all cases if the disease is severe, plough up, apply quicklime, and cultivate the land for other crops for several years. If *Rhizoctonia* has been destructive, it will probably be unsafe to grow mangolds or carrots on the same land until several years have elapsed. [W. G. S.]

Lucilia cæsar, Linn. (the Green Flesh-fly, or Green-bottle), is one of the flies which



1, Lucilia cæsar; 2, Musca domestica; 3, 4, 5, 6, eggs, larva, pupa, and imago of the Blow-fly (*Caliphora vomitoria*)

give rise to 'maggots' in sheep. Other flies of similar habit are *L. sericata* and *Sarcophaga magnifica*. It should be remembered that a clean sound sheep is not in the least attractive to the fly, but that a dirty and matted fleece, accompanied by neglected sores, is an irresistible attraction, and attention should be directed, not to the impossible task of exterminating the flies, but to keeping the sheep, and especially the lambs, in a clean condition, and treating any sores with an antiseptic lotion. [C. W.]

Lumbago.—Under the name of 'chine felon', lumbago has been recognized in old books on farriery, and is usually spoken of as rheumatism of the lumbar muscles in modern works (see RHEUMATISM). When rheumatism is localized in the fascia of the loins, the pain and stiffness is similar to that experienced by men. In animals it is often associated with parturition, cows and sows appearing to suffer more frequently than other species. Lumbago shortly after calving may be mistaken for milk fever, the animal's unwillingness to rise being due to the pain experienced when attempting to do so. Pastured cattle are sometimes thus affected, and remain on the ground for many days, but ultimately get up without assistance. Tenderness on pressure over the loin is a marked symptom, with general rigidity, hidebound, staring coat, and inappetence. *Treatment* consists in giving a brisk purgative, followed by salicylate of soda, nitre, glauber salts, or other salines, and liniments to the skin over the region affected. A warm flat-iron pressed over the loins often gives relief. [H. L.]

Lumber is the American synonym for sawn timber, and *lumbering* is the term applied to the extraction of timber on a large scale. The lumber industries have long ranked next to agriculture in their contribution to the national wealth of the United States. The chief lumber tree is still the White Pine (*Pinus Strobus*, known in Britain as the Weymouth Pine, whose timber, here called 'yellow pine', forms our chief coniferous import) of the Mississippi drainage forming the north-eastern forest tracts, though the vast virgin woodlands once thought almost inexhaustible have already been nearly denuded of first-grade timber. Formerly the trees had an average height of about 110 ft. and a girth of 8 to 10 ft., but of late years the size of the marketable log has greatly decreased, until now much of the White Pine brought to mill is under 10 in. diameter. During the last ten years many of the White Pine lumbermen and millers have, owing to exhaustion of supplies, gone to work other kinds of lumber in the southern States and the Pacific region. Next to White Pine among the conifer lumber of the north-eastern forests come the Hemlock (*Tsuga canadensis*), largely used in construction, and the Spruce (*Picea rubens*), now mostly used for wood-pulp (along with poplars, &c.). In the south-eastern forests the chief lumber tree is the Longleaf Pine (*Pinus palustris*), averaging 90 ft. high and 20 in. diameter, whose strong durable timber is sold as 'pitch pine' in Britain. In the Pacific Coast forests the chief lumber trees are Red Fir in Oregon and Washington, called Douglas Fir in Britain (*Pseudotsuga Douglasii*), and Redwood (*Sequoia sempervirens*) in California. The Red Fir averages about 200 ft. high and 4 ft. in diameter, while the Redwood averages about 225 ft. high and 8 ft. in diameter when fully mature, although logs

of both Redwood and Big Tree (*Sequoia gigantea*) are often over 10 ft. in diameter. In the interior conifer tracts the chief lumber trees are the Red Fir, the Western Yellow Pine (*P. ponderosa*), and Engelmann's Spruce. Of these the Yellow Pine is the largest, 90 ft. high and 3 ft. diameter, while Red Fir here only averages about 70 ft. high and 2 ft. diameter, and the Engelmann Spruce is about 60 ft. high and 2 ft. diameter. In these vast lumbering industries the tools, appliances, and machinery used in felling, logging, transporting, milling, and distributing the timber are usually of the highest grade of practical utility. In the north-eastern forests the White Pine is usually cut in summer and autumn, skidded and dragged by horses to the roads in early winter, and sledge-hauled over ice to the banks of streams in late winter and early spring, and then afterwards floated down to the mills, where the logs are caught by floating booms. In the Pacific Coast forests the great giant logs of Red Fir and Redwood are usually extracted by skidding with wire cables, often more than half a mile long, operated by donkey engines, either stationary and of large size, or else made to drag themselves through the forest to where they are wanted. From such forest depots the transport to the mill is usually by rail, powerful machinery and great skill being required in the handling of such enormously large and heavy logs. Flumes or carefully graded watershoots are also much used in this district for the transport of manufactured lumber by water, and some of these flumes are forty miles long. Huge sawmills are built on piles over tide water, and the converted timber is shipped direct from the saws and dry-kilns on vessels moored alongside. Some idea of the extent of the lumber industry may be formed from the estimate that, apart from large exports to Britain, the total consumption of wood in the United States exceeds 20,000,000,000 cu. ft., and about three-fourths of this are needed as fuel. In all estimates and transactions concerning lumber a peculiar unit of measurement has been adopted in the United States, namely *board measurement*, or B.M. The *board foot* unit is generally defined as a board 1 ft. long, 1 ft. wide, and 1 in. thick; but in actual trade practice it is equal to 144 cu. in. (or $\frac{1}{12}$ of a cubic foot) of manufactured lumber in any form. In buying logs by this B.M. measure, one must first estimate what each log will yield in 1-in. boards. For this purpose timber-tables are used, which give in board-feet the contents of logs of various lengths and diameters. Under this system the buyer pays only for the saleable timber in each log when converted, while the inevitable wastage in slabs and sawdust is not included for payment. This is merely a different way of arriving at much the same object as is aimed at in the customary British 'square of quarter-girth' method of measurement, which estimates the contents of a log to be $21\frac{1}{2}$ per cent below its true cubic contents; for 1000 board feet of wood (which are equal to $83\frac{1}{3}$ cu. ft.) are produced from a log containing about 110 cu. ft. in actual contents. [J. N.]

Lumbricus. See EARTHWORM.

Lunaria (Honesty), a genus of Cruciferæ allied to Alyssum. *L. biennis* or *annua*, 2 ft. to 3 ft., a native of Scandinavia, is a delightful old garden plant, as much grown for the sake of its large, silvery, round, flat seedpods as for the purple blossoms which precede them. It is very well adapted for growing in masses in the wild garden. *L. rediviva* is a perennial kind. They will both thrive in half-shady positions in sandy soil. Seeds of *L. biennis* should be sown in the spring, while *L. rediviva* is propagated by division or from seeds. The flat silvery fruits of these plants are very decorative, and are used when dried for the ornamentation of rooms, &c. [W. W.]

Lungs.—The structure, function, and diseases of the lungs are described in the next article, to which reference should be made.

Lungs, Diseases of.—Domesticated animals are in all probability much more liable to suffer from lung complaints than those living under natural conditions, since environment does play a very significant part in respiratory diseases. This is typically exemplified in the case of monkeys and parrots imported into Great Britain—there being a high percentage of mortality recorded amongst these from pneumonic troubles, ascribable to altered conditions of life. It is a well-known fact that cattle kept indoors —especially in ill-ventilated byres—are particularly prone to tuberculosis, whilst the freedom of West Highland cattle from that disease is indicative of the salutary influence exercised by a life in the open air—these beasts being seldom housed. That lung complaints should be prevalent is easily conceivable when one comes to consider how readily infection may occur by the respiratory tract, in conjunction with the vitiated atmospherical conditions to which domesticated animals are so frequently exposed. The lungs represent the aerating area of the circulatory system; consequently any interference with their normal functional activity imperils the health of the blood stream, and this in its turn may throw other portions of the animal economy into disorder, or, it may be, into disease. Incidentally it must be mentioned that the lungs largely consist of divisions and subdivisions of the bronchial tubes, and the minute bronchioles at their terminals form the saccular dilatations known as 'infundibuli', each 'infundibulum' constituting an 'alveolus' or air-space. In addition to the spongy parenchyma of the lungs, the mass is made up of elastic areolar tissue in conjunction with the bloodvessels. In the fœtus the air-spaces or alveoli are closed, only becoming dilated in extra-uterine life. This is of some significance, because microscopic examination is occasionally resorted to in order to ascertain whether the newly born has had an independent existence. If the alveoli are dilated it is generally accepted as evidence of post-natal existence. An interesting feature in connection with the blood supply to the lungs is that the pulmonary artery carries impure or *venous* blood, whereas the pulmonary vein carries arterial or pure blood. The nutrient vessel of the lungs is the bronchial artery. The lungs of cattle have a large amount of interstitial tissue,

consequently when involved in disease, *e.g.* contagious pleuro-pneumonia, these areas stand prominently out, giving the lungs the so-called 'marble' appearance. The delicate texture of the lungs is protected by serous coverings, consisting of the pleural membranes, each lung having two surfaces, namely, a costal or thoracic surface and a pulmonary one; in other words, an inner and an outer surface over which the pleura is reflected. As the pleural membranes are in contact with the lungs, it follows that when the substance of the lungs is affected the pleural membranes are liable to participate. In the ox this is usually the case, so that, in this animal, pleuro-pneumonia—which must not be confused with contagious pneumonia—is frequently encountered. Nevertheless, disease of either structure may exist independently. In cattle both pleural sacs are quite separate, but in the horse there is a communication (such communication being through the posterior mediastinum), this membrane being cribriform, *i.e.* riddled with minute pores, so that when there is fluid in, say, the right pleural sac, there may be, through this channel of communication, a similar condition in the left sac. Most of the pathological processes involving the bronchial tubes, the lungs, pleural membranes, and structures in juxtaposition to the lungs are initiated through the pathway of the air tubes, though occasionally they have their origin in some form of external injury. Viewed in the light of modern pathological knowledge, it is a fairly safe deduction to assume that most pneumonic diseases are the result of *direct infection* by micro-organisms, and many diseases that were formerly ascribed to chills, &c., are really organismal. The following constitutes a brief survey of some principal lung complaints.

EMPHYSEMA.—Emphysema of the lungs is not an uncommon disease, and is denoted by a spongy enlargement of the whole of the lung substance. When the lungs are handled they convey the sensation of a substance puffed up by air, which is precisely the condition of the organ. When the lungs are examined microscopically, the air spaces, distributed throughout the substance of the lungs, are seen to be ruptured, the walls of adjacent alveoli being fused, producing larger air cavities, hence their spongy texture. Emphysema is apparently the result of hyper-distension of the air spaces, arising from various causes. When the chest cavity of an animal with emphysematous lungs is opened, the latter fail to collapse, remaining distended. In horse (cattle), emphysema of the lungs is often met with post-mortem.

BRONCHIECTASIS.—Whenever the bronchial tubes have been subjected to prolonged irritation, such as that resulting from coughing and bronchitis, they gradually undergo a permanent dilatation, constituting the condition referred to.

BRONCHITIS.—This may be *acute* or *chronic*, and may affect the large, the medium, or the small air tubes, its gravity being proportionate, according to the calibre of the tubes implicated. When the smallest bronchial tubes are affected there is a greater tendency towards catarrhal pneumonia than when the medium or larger tubes are implicated. Bronchitis in animals has four main causes operative in its production, namely: (a) *mechanical*, (b) *parasitical*, (c) *atmospherical*, and (d) *specific* (organismal). The principal mechanical causes of bronchial inflammation are those arising from the irritation induced by the inhalation of fumes, smoke, &c.; likewise by the entrance of liquids accidentally passing into the respiratory tract, the last-named being an occasional accident in the drenching of sheep (cattle.) A similar condition of affairs may be induced through the forcible administration of liquids by the mouth when animals are in a comatose condition. The invasion of the air tubes by parasites is common in cattle, sheep, pigs, and poultry; more rarely, the horse, dog, cat, &c. In cattle and sheep this form of bronchitis is known as 'husk' or 'hoose'; and in poultry, pheasants, turkeys, partridges, &c., as 'gapes', and the minute worm producing it 'the gapeworm' (*Sclerostoma syngamus*). The worm producing husk in cattle is termed *Strongylus micrurus*, whilst that infesting sheep is the *Strongylus filiariæ* and *Strongylus rufescens*. The irritation induced by these worms is chiefly confined to young stock, and moisture is favourable to the development of the parasites, so that it is in the autumn when most cases occur. Atmospheric and specific causes are those resulting from exposure to adverse climatic conditions in relation to the first named, whilst the specific factors comprise various micro-organisms, such as micrococci, the bacilli of glanders, &c.

Chronic Bronchitis is distinguished from the acute form by the absence of fever and its slower course; but in both forms there is expectoration, and the so-called mucous râle, that is sound produced by air passing through the mucus in the tubes. Acute bronchitis is frequent in the horse during influenza, and in the dog whilst labouring under distemper. *Treatment* comprises rest, counter-irritation, keeping the patient in equable and moist temperature, the use of medicated inhalations, warm clothing to the body, bandages to the limbs in the horse, together with linseed gruel and bran mashes as food. Medicinal treatment varies according to the duration of and severity of the complaint.

ACUTE CONGESTION OF LUNGS.—The horse is the most frequent sufferer from this complaint, and it generally occurs in those animals compelled to undergo a violent degree of exertion without being previously got into a fit condition to bear such; hence the reason why hunters are more prone to this complaint than others. This disease is due to sudden engorgement of the lungs with blood, or, in other words, the lungs become 'logged'. Apart from this, acute lung congestion arises through metastasis, *i.e.* the transition of inflammatory activity from some other organ or structure, as occasionally happens in 'founder' or 'fever of the feet'.

Pulmonary apoplexy quickly proves fatal unless very active measures are adopted for the relief of the patient. Bleeding and stimulants should constitute the sheet-anchor of treatment, but this trouble demands immediate professional assistance, and the sooner such is obtained the more the likelihood of a successful issue.

Acute Pneumonia.—All domesticated animals are equally susceptible to inflammation of the lungs, of which there are two distinct varieties, one being called 'croupous' or 'lobar', the other 'catarrhal' or 'lobular' pneumonia. In the first named the changes in the lung affect the *whole lobe*, and are characterized by three phases, namely: (1) *congestion* or *engorgement*, (2) *red hepatization*, (3) *grey hepatization*; though these changes follow in sequence they may be intermingled. In catarrhal or lobular pneumonia the pathological changes are confined to isolated areas, or to the lobules of the lungs, and are denoted by catarrhal products within the air cells.

There is a third form of pneumonia, known as *interstitial*, which is particularly well marked in *contagious pleuro-pneumonia* of the ox. In this variety of pneumonia it is the intervening connective tissue between the lobules that is the chief seat of the inflammatory action. In the horse there is a variety of pneumonia known as *septic* or *contagious lung fever*, a very fatal malady. In all cases of lung inflammation the percentage of deaths is high, whilst the young are more responsive to treatment. When the heart and other organs are enfeebled by disease, as happens in influenza of the horse, swine fever in pigs, and distemper in the dog, there is greater liability towards a fatal issue. The chief symptoms indicative of pneumonia are: rigors, followed by fever and elevation of internal temperature; loss of appetite, and in milch-cows diminished lacteal secretion; thirst; constipation; a desire for fresh air. If pleurisy be superadded to the malady there is a short suppressed cough, pain when the ribs are pressed, and grunting. As the disease advances, the breathing becomes more and more laboured, the nostrils dilated, and the facial expression indicative of anxiety. Duration of the disease varies, whilst the treatment is similar to that already indicated under 'Bronchitis' and 'Acute Congestion of the Lungs'.

Tuberculosis.—Unfortunately for man and animals, tuberculosis is all too prevalent; but there is no doubt that, with improved sanitary conditions and active legislative measures, the malady will gradually be reduced to a minimum, but the writer does not believe it will ever be entirely eliminated. It is a disease that follows the lines of social intercourse amongst man and animals, not excluding poultry. It has been clearly shown that human and bovine tuberculosis are identical maladies and intercommunicable; some doubt has indeed been thrown upon the identity of avian and human tuberculosis, though the writer believes that these also are intercommunicable, although the bacilli of avian tuberculosis may have become modified. Horses do suffer from tuberculosis, though less frequently than man and some other animals; and it is a remarkable fact that the principal tubercular lesions in Equines are not in the lungs but in the spleen, whereas in cattle, swine, cats and monkeys, &c., the chief lesions are in the lungs. In poultry the liver and the mesenteric glands are most commonly implicated. Tuberculosis is due to the entrance of minute organisms into the system, and the discovery of such is attributed to Koch, hence the name *Koch's bacilli* applied to them. The organisms are exceedingly minute, and require high powers of the microscope for their demonstration, and can only be observed after staining with suitable reagents. A great deal has been said about the *hereditary* nature of this complaint, and evidence would seem to prove that it is hereditary, but to nothing like the extent formerly supposed. Infection is the chief source of its dissemination, and with the diffusion of knowledge concerning the multifarious channels through which it may be conveyed, there will be a corresponding decline in its prevalency. Popular names for this malady are *scrofula*, *grapes*, *ulcers*, *wasting*, &c., and, in poultry, *going light*. Tuberculosis is not necessarily confined to the lungs, but may invade almost every organ in the body, though the muscular tissue is singularly exempt from the ravages. Tuberculosis of the udder is not uncommon in cattle. *Lung tuberculosis* is denoted by the appearance of the so-called *tubercles*, which are at first of microscopic size, but in cattle and horses may attain large tuber-like masses weighing several pounds. The pleural membranes—especially that part covering the ribs and the diaphragm—are, in cattle, commonly the chief seat of the disease, and when inspecting a carcass this muscular partition and the lymphatic glands—especially the bronchial lymphatics—are chiefly referred to for evidence of the disease. The micro-organisms seem to find the lungs a congenial soil, and induce, by their presence, the new growths previously referred to. The chief portal for entrance of the germs into the blood stream is in all probability through the respiratory tract, but also may be by ingestion, as the disease has been induced by feeding animals on tuberculous flesh, milk, &c. Sunlight and a free supply of oxygen (pure air) unquestionably constitute the best methods of fortifying the system against the ravages of these pernicious organisms. Tuberculosis assumes both acute and *chronic* forms, and if a patient affected with a chronic form is exposed to debilitating extrinsic influences, the malady is liable to develop into an *acute* attack, which usually runs its course quickly. Being insidious in its onset, veterinarians often experience difficulty in the detection of tuberculosis; but since the introduction of *tuberculin* there is now a test that will afford reliable evidence of its presence, even in its initial stages. This test has been, unfortunately, much abused, but there is a consensus of opinion, that when judiciously employed it is as near perfection in attaining its object as can be reasonably expected. No matter whether an animal is affected with tuberculosis of the udder or any other portion of the body, tuberculin will, if properly employed, disclose its existence by producing a rise of temperature. The ordinary symptoms of lung tuberculosis are the presence of a cough and a want of thriftiness, but some cattle are in the pink of condition and yet, on slaughter, are found to be badly affected with the disease. The most economical method of dealing with it is to maintain a vigorous condition of the young stock; to have the

cattle periodically tested with tuberculin, and to get rid of all reactors; combined with strict attention to hygiene.

PLEURISY.—All animals are liable to this complaint, which consists of inflammation of the pleural membranes. It is a painful malady, and one very liable to run an unfavourable course, especially when existing as a complication of some other debilitating disease. One of the worst features about it is the tendency towards effusion, or *dropsy of the chest*, and if the fluid is abundant it causes collapse of the lungs, which are then unable to perform their functions. It assumes both *acute* and *chronic* forms, the latter being indicated by the formation of adhesion between the pleura and chest wall. In *acute* pleurisy the temperature is about 104° F. or 105°, accompanied by a painful cough, and the so-called *pleuritic furrow* is found running along the floor of the chest, not unlike that seen in *broken wind*. As the disease advances, the breathing becomes very laboured and painful, superadded to which dropsical swellings often appear upon dependent parts of the body. The pulse is, at first, hard—about 80 per minute, but when effusion occurs it becomes softer and muffled. In the early stages there is a so-called *pleuritic rub* or *friction sound* heard on auscultation of the chest. As this is a serious malady, professional aid is requisite.

CONTAGIOUS PLEURO-PNEUMONIA OF CATTLE. —Fortunately for the agriculturists of Great Britain, this communicable malady is no longer existent in the old country, but is constantly present in certain Continental countries and other parts. Contagious lung fever would unquestionably soon be with us again, were it not for the strict legislative measures adopted by the Board of Agriculture. The Government of the Dominion and other States regard these measures with disfavour, pleading that the malady does not exist with them; but considering the intercommunication of the cattle between various States, and their importation into ports where legislative measures are not stringent enough, it is expedient, in the interests of the British agriculturists, that such measures should be rigorously adhered to. The most characteristic post-mortem lesion of contagious pleuropneumonia is in connection with the interstitial tissue of the lungs (interstitial pneumonia), conferring the so-called *marble appearance* upon them. Areas of diseased lungs sometimes become encapsuled and the animal makes an *apparent* recovery, but this encapsuled diseased area is liable to break down and so constitute a renewed focus of infection.

GLANDERS OF THE LUNGS. This subject is dealt with in the article GLANDERS AND FARCY, which should be consulted. [F. T. B.]

Lupin.—The Lupin, like many of our most valuable forage plants, belongs to the nat. ord. Leguminosæ. As a fodder crop it is decidedly inferior to Clover, Lucerne, or Sainfoin, and is mainly used for growing on poor sandy soils, which will not support the finer leguminous crops.

There are three well-known varieties, distinguished by the colour of the flower—Blue Lupin, Yellow Lupin, White Lupin. In habit of growth they are very much alike, all being deep-rooted and having stout stems which become very woody during flowering stage. The yellow (*Lupinus luteus*) and the blue (*Lupinus angustifolius*) are the varieties most commonly cultivated. When used as forage the yellow variety is the better, the stems being more succulent and the leaves more abundant than in the blue; the stems of the latter variety are more tough and fibrous, but it produces more seed than the yellow kind. Trial plots conducted by the writer gave results generally in favour of the Blue Lupin, the seed germinated better, and as a rule grew more freely and yielded a heavier crop.

In field culture the best time to sow is from the middle to the end of April. If sown too early the young plants, which are very tender, are liable to be cut down by frost. The seed may be broadcasted at the rate of 2 to 2½ bus. per acre, or drilled at the rate of 1½ bus. in rows 12 to 18 in. apart. On poor sandy soils, previous to sowing the seed, mineral manures—superphosphate, kainit, and gypsum—should be applied at the rate of 1½ to 2 cwt. each per acre.

After germination the plants grow slowly at first, but when thoroughly established the growth is very rapid, and a height of 2 to 3 ft. is attained in a very short time, and when at the flowering stage the Lupin will yield from 16 to 20 tons of green fodder per acre.

The crop may be fed off with sheep, made into hay, or left to produce seed. When fed by sheep it should be folded whilst the crop is young, before the stalks become hard and woody; if made into hay, cutting should take place before the first flowers open. In some Continental countries where labour is plentiful and cheap, the practice is to cut the crop when the first-formed flowers have produced seeds; children are then sent over to gather up the seedpods before making the rest into hay. The hay produced by this method is, however, very tough and fibrous. Lupins being very succulent and difficult to dry, the crop is usually piled on poles set up in the form of a pyramid, a method which is largely practised in Germany for drying Lucerne. When grown for the seed alone, the treatment adopted in harvesting beans answers very well. As Lupin seed does not ripen well in Britain, its chief use in this country is for feeding off green or ploughing in as manure. For the latter purpose Lupins are largely grown on the poor sandy soils found in various parts of Germany and in Prussia. Here the usual practice is to sow the yellow variety in June, and when in full flower a roller is passed over the crop, which is afterwards ploughed in and land prepared for winter corn. By this system a better crop of corn and potatoes is often obtained than by applications of farmyard manure.

The value of Lupins in assisting in the accumulation of nitrogen in the soil has been made the object of a series of experiments by Dr. Schultz in Germany. After trials with thirty leguminous plants, Dr. Schultz came to the conclusion that on the whole the most suitable crops to grow for soil improvement are Lupins (yellow,

blue, or white), hairy vetch, kidney beans, peas; and it was estimated that any of these crops ploughed in at the time of flowering would yield on an average an amount of nitrogen about equal to that contained in from 9 to 15 tons of farmyard manure. In addition to the nitrogen furnished by ploughing in the crop, there would be a large accumulation in the soil and roots of the plant, which would even exceed the amount yielded by the leaves and stems.

Compared with other leguminous fodder crops, Clover, Lucerne, or Sainfoin, the Lupin is not so palatable. The juice has a bitter flavour which at first sheep and cattle do not like, and pigs refuse to eat the plant. The nutritive value is also inferior to the above-named crops; this is due chiefly to presence of a high percentage of indigestible fibre and a less amount of sugar. Hence we may conclude that the principal use of the Lupin lies in its capacity to produce large crops of nitrogenous herbage on poor sandy soils, thus causing large accumulations of nitrogen and humus, and rendering unproductive land capable of yielding profitable crops of grain and roots. [W. SOM.]

Lupinus, a large genus of very ornamental hardy and half-hardy annuals and perennials (nat. ord. Leguminosæ), mostly with blue or purple flowers, more rarely yellow or white. The species in cultivation are chiefly natives of western North America, but hybrid forms are much more numerous in gardens, particularly those derived from *L. polyphyllus*, which vary from 3 ft. to 6 ft. in height. Lupins are of easy cultivation in almost any soil. Seeds of the annual kinds are sown outdoors in April and May, and the perennials are sown or divided at the same season. The Tree Lupin (*L. arboreus*), which grows 5 ft. or more in height and forms a spreading bush, has fragrant yellow flowers, and is particularly valuable for making a bold display on the poorest soils. There is an excellent white variety of it named Snow Queen. [W. W.]

Luxations.—Dislocation and luxation are terms generally applied to the condition of joints whose articular surfaces are incorrectly opposed as a result of extension of the restraining ligaments; but surgeons recognize dislocations of other structures—of organs, such as the heart. In overgrown or weakly animals the patella bone suffers dislocation and reposition during progression. Partial dislocation of the fetlocks is common to overworked horses, and may be seen in unbroken colts with unduly round bones. This knuckling over is also witnessed as a result of spinal affections, when the muscles fail to receive proper innervation. Any brain or spinal trouble, or hæmorrhage inducing faintness, may lead to temporary luxation of joints. Any treatment must be based on a correct diagnosis of the particular cause. See JOINTS, DISEASES OF; LAMENESS. [H. L.]

Luzula, a genus of the nat. ord. Juncaceæ, to which the plants known as Woodrushes belong. See WOODRUSH.

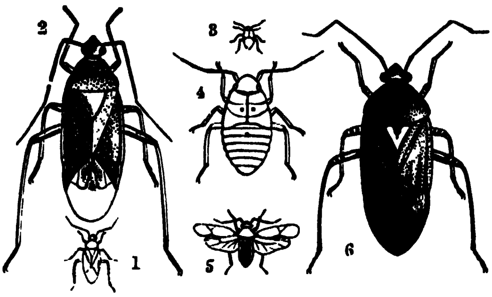
Lychnis (Rose Campion), a genus of Caryophyllaceæ, allied to Silene, also known as Agrostemma and Viscaria, comprising about thirty species of annual and perennial herbs, natives of the temperate regions of the northern hemisphere. The hardy herbaceous species are those chiefly grown. They are of easy culture and include some charming rock-garden plants, notably *L. Lagascæ*, a dwarf alpine with dark rose-coloured flowers, and *L. Viscaria* (German Catchfly), a native plant with rosy-red flowers, of which there are white and double-flowered varieties, and a superior variety named *splendens*. *L. chalcedonica*, scarlet flowers, *L. grandiflora*, scarlet flowers, and *L. Haageana*, a hybrid with variously coloured flowers, are among the best border kinds. *L. flos Cuculi* is the familiar native Ragged Robin, the double-flowered variety being a good garden plant. Lychnises thrive in any ordinary soil, but are best suited by a rich light loam. Some of the species may be treated as annuals with good results by sowing the seeds in heat in early spring and planting the seedlings out in June. They are benefited by transplanting, and the perennials may be propagated by division. See also CORN COCKLE. [W. W.]

Lycium (Box-thorn), a large genus of hardy or half-hardy deciduous free-flowering shrubs (nat. ord. Solanaceæ), widely distributed. Mostly of climbing or trailing habit, and armed with spines. The species most frequently met with in gardens are: *L. chinense* (*L. barbatum*), Box Thorn or Tea Tree, a rapid-growing climber from South Europe, which will thrive in almost any situation, and is excellent both for the seaside and for planting in smoky towns. The small violet-red flowers are succeeded by handsome scarlet drupe-like fruits. *L. pallidum*, from New Mexico and Arizona, about 4 ft. high and of stiff upright habit, bears large greenish, tubular flowers in May and June. Lyciums are generally grown against trellises or walls. They are not particular as to soil, and are easily propagated by cuttings, layers, or suckers in autumn. [W. W.]

Lye.—The term 'lye' is applied to solutions particularly of the alkalis soda and potash. It is sometimes applied to solutions of other chemicals. Formerly the term was specially applied to solutions which had been extracted from ashes, such as wood ashes and the ashes of various plants. Such solutions contained the alkaline carbonates of potash and soda. The term is now practically applied only to solutions of potash and soda. Thus a soda lye means a solution of the alkali caustic soda or sodium hydroxide. The strength of the solution may vary, and is measured by the specific gravity of the solution. [J. H.]

Lygus, a genus of plant-bugs more or less injurious to a variety of plants, and occasionally the cause of rather severe injury, especially to potato haulm and to the leaves and blossom of fruit trees. The species most usually complained of in this country is *L. pratensis*, which also occurs in the United States, where it attacks tobacco and beet plants and pear trees, the actual fruit of the latter being injured. It is known in America as the 'tarnished plant-bug'. The insects pass the winter both in the mature form and as eggs, the hibernating females lay-

ing eggs on the plants in May. The young bugs which hatch out pierce the leaves and stalks with their beaks and feed on the sap. The punctures cause discoloured blotches. They become mature in July, and then possess wings. It is much easier to combat them in the young stage, when, as they are unable to fly, they can



Bugs of the genus Lygus

1 and 2, *L. pratensis*, nat. size and magnified; 3 and 4, the immature insect; 5 and 6, *L. umbellatarum*.

be caught in large numbers by jarring the plants over tarred boards, or by dragging tarred sacks over potato beds. Spraying with paraffin emulsion is also effective. [C. W.]

Lyme Grass, a tall, sand-binding grass. See Elymus.

Lymph. — The lymph is the fluid which plays the part of the middleman between the blood and the tissues of the body, supplying them with nourishment. The liquid part of the blood is constantly soaking through the walls of the bloodvessels and accumulating in the tissues, and would soon cause a condition resembling general dropsy, were it not for the absorbent action of the lymphatic system of vessels. These so-called lymphatics originate as very minute hairlike tubes over the whole body, and closely resemble veins. They join together in the same manner as veins do, and hence gradually become larger, until ultimately they are all collected into two main trunks which open into the large veins near the heart, and empty their contents directly into the blood stream.

All along the course of the lymphatic vessels we find the so-called lymphatic glands arranged at definite intervals, and the function of these glands is to act as natural filters, and if possible keep back or destroy any harmful substance which has found its way into the lymph stream. For example, in the case of a poisoned wound on the hand, the lymphatic glands situated in the armpit may arrest the disease germs flowing through them, and prevent their gaining access to the blood stream and, as a result, causing probably death from blood poisoning. When a lymphatic gland is endeavouring to destroy germs it usually becomes swollen and painful, and it will depend on the deadly nature of the germs and the powers of resistance possessed by the gland whether the disease will be overcome or not.

Lymph is usually a colourless, watery-like liquid, although in certain parts of the body, as the abdomen, the lymph coming from the walls of the bowels during digestion is more milky in appearance, because it contains fat in a finely divided or emulsified state. In most situations the lymph is composed of a liquid which closely resembles blood plasma, and has fewer or more cells floating in it.

In a state of health the liquid part of the blood, which soaks all the tissues of the body with nutriment, is carried away by the lymphatics, and does not tend to accumulate in any quantity; but in weakness or disease the circulation becomes lowered, and dropsical swellings appear in certain positions; in the horse the limbs and the floor of the abdomen swell, in cattle the dewlap, throat, &c. As a rule this disappears with exercise, which stimulates the circulation. In severe cases which terminate fatally, the affected parts, when cut into after death, appear moist and watery, as is exemplified in fatal cases of fluke liver, or so-called liver rot in sheep.

In emaciated carcasses of animals which have been slaughtered, this dropsical liquid is a marked feature, the dependent parts being quite watery and flabby, and do not become firm and set as is the case in healthy butcher meat; and consequently such flesh is usually condemned as unfit for human food. [J. R. M'C.]

Lymphangitis.—This disease is perhaps better known as 'Monday morning leg', owing

Lymphangitis

to its frequent occurrence after the rest of the previous day. It is erroneously called in some districts a 'shot of grease', as greasy legs (see Grease) are of the kind also subject to lymphangitis, and the two diseases may occur at about the same time. The name of 'weed' is also given to

it. More often the hind, but not infrequently the front legs are subject to this inflammation of the absorbent vessels. It is sudden in its invasion, the apparently healthy horse of the previous evening being discovered with a swollen and painful leg, on entering the stable. Highly-fed animals with slow circulation, as dray horses, and those called upon to do heavy hauling and liberally 'corned', are particularly liable to it; but the farm horse and those of the private stable are not immune. Extreme tenderness to the touch, even before the swelling commences; great lameness; blowing with pain; patches of sweat upon the limb; a frequently well-defined line between the inflamed and unaffected parts; cording or standing out of the lymphatic vessels on the inner aspect of the thigh or arm, and extending to the glands of the groin or axilla—these are the prominent symptoms; but some horses suffer febrile disturbance and loss of appetite, while all exhibit pain and fear if compelled to move, often catching up the suffering member with a jerk that threatens to capsize the patient.

Treatment.—Except in the case of debilitated and old animals, the abstraction of blood from the jugular veins (not from the toe) is followed by early relief. A suitable aperient should be given, as a bold dose of aloes, if bleeding is not practised, or a pint or two of linseed oil, followed by 2 to 4 dr. doses of nitre, and ½ oz. of bicarbonate of potash every six or eight hours. Ounce doses of salts (magnesium sulphate) are also advised in gross animals, and as a preventive, in 3 or more ounces twice a week in a bran mash. The pain may be relieved by fomentation, and a liberal supply of soft bandaging soaked in lead lotion, made by mixing an ounce of the Goulard's extract with a quart of water; or dressing with an oily lotion of 1 part Goulard to 9 of linseed oil. The latter is advised where frequent attention cannot be given. Soft hay bands soaked in water make good substitutes for proper bandages. When the more acute symptoms abate, exercise should be enforced, a few minutes twice daily. Iodide of iron, in one or two dram doses, with similar quantities of nitrate of potash, may be given twice daily, to clear up the limb. There is always a tendency to recurrence of this malady, and the Epsom salts are specially advised after a first attack. Subjects of this disease should be exercised regularly when not worked. [H. L.]

Lymphangitis epizootica. — An infectious septic inflammation of the lymphatics among horses in South Africa was introduced into this country on the return of the army, and it is hoped that the energetic measures taken by the Board of Agriculture have stamped it out, although a few isolated cases have been heard of at the time of writing. The vessels enlarge and thicken, with a tendency to ulcerative sores of a chronic character. There is considerable resemblance in these sores to those associated with glanders farcy, but the specific *Bacillus mallei* is not present. Notice to the authorities is required in both. See GLANDERS, LYMPHANGITIS, and LYMPHATICS, INFLAMMATION OF. [H. L.]

Lymphatics, Inflammation of.—Inflammation of the lymphatic vessels shows itself in a corded and painful condition, easily seen and traced when from a wound or injury to a limb or other part of the body. Thorns, abrasions from brushing, or the clench of a nail sticking up, from cracked heels, or septic matter from other sources may cause it, or purposeful inoculation, as in the mallein test (which see) or the tuberculin test, the results of which may be vitiated by a dirty needle or the introduction of foreign matter upon the skin. Extension to the lymphatic gland nearest may result in abscess, which should be fomented with an antiseptic lotion, while giving mineral tonics internally, the sulphates of iron, copper, and zinc, or iodide of iron is recommended for horses and cattle. [H. L.]

Lyonetia clerckella (the Apple-leaf Miner).—The caterpillars of this small moth form sinuous burrows in apple and cherry leaves; as many as four of these tunnels may often be found on a single leaf. This moth occurs over most of England; it appears in April, June, August, and September, and again in November. It is about ⅓ in. in expanse of wings, the front pair are narrow and lanceolate, brownish-white, with a long brown line beyond the middle, with a narrow dusky band and three dusky streaks, and at the apex a prominent black spot; the hind pair are brownish-grey. The abdomen is clothed with shiny steely scales. The females hibernate in crevices, where they keep dry. The egg is laid on the leaf, and the young larva at once enters the tissue and forms a gradually widening tunnel, which may be brown, grey, or black, the end showing lines of black 'frass' deposited by the larva inside. The larva is green, and reaches 6 mm. in length, and is flattened in form; maturity is reached in four to five weeks. They spin their cocoons on the leaves; the cocoons are cylindrical, composed of white silk, and held in position by long lateral and other strands of silk attached to the leaf. The pupa is pale apple-green, the front and wing-cases fawn-coloured. This stage lasts from ten to twenty days. The only treatment so far known is hand-picking the attacked leaves early in the summer. [F. V. T.]

Lysimachia (Loosestrife), a large genus of Primulaceæ, with white, yellow, and, more rarely, blue flowers, of wide distribution, and very variable in habit. They are of easy cultivation, and prefer a moist situation, as by the margin of a stream. The best known is *L. Nummularia*, the yellow-flowered Creeping Jenny, which is a great favourite with cottagers. The other species cultivated are of erect habit. These include *L. ciliata*, *L. lanceolata*, *L. vulgaris*, and others, with yellow flowers, and *L. clethroides*, a graceful white-flowered Japanese kind. Their spreading habit makes it desirable that they should be grown by themselves. They are very easily propagated by division in autumn or early spring. [W. W.]

Lythrum (Purple Loosestrife), a genus of Lythraceæ comprising about twelve species of hardy or semi-hardy herbs. *L. Salicaria* (Common Purple Loosestrife), a native perennial

waterside plant with reddish-purple flowers, is the most decorative, and the varieties *roseum* and *superbum* are superior to the type. They should be grown by the side of water or in marshy ground, either as isolated specimens or in beds. Lythrums are of very easy cultivation and may be freely increased by division. *L. Græfferi*, South Europe, bright-pink flowers, is well adapted for growing in hanging baskets in greenhouses. [W. W.]

M

Macaroni.—Macaroni is a preparation of wheat, and more specifically of the hard translucent wheats of southern Europe, which are rich in gluten and other nitrogenous substances. The name is derived from the Italian verb *maccare*, to bruise or crush, and refers to the process of manufacture. Genoa was the original home of macaroni, which was made exclusively from hard Italian wheat, but the manufacture has extended throughout all Italy as well as into southern France, while imitations made from softer wheat are prepared in America, Britain, and Germany.

The meal of these hard wheats, known in that state as semola or semolina, is mixed into a dough with boiling water simply; some makers add flavouring matters as well as turmeric or saffron to produce a richer yellow colouring. The dough is packed into a cylinder the end of which is pierced by holes of the required diameter, and the soft mass is pressed through these holes by a plunger. Where tube or pipe macaroni is wanted, these openings have mandrils centred in them so as to give a hollow core. Vermicelli and macaroni are produced in this way. When the cylinder is horizontal and the end openings take fanciful shapes such as stars, crosses, &c., the issuing dough is cut across by an oscillating knife, so as to secure thin slices of the required shape, which are then known as *pasta* (It. for paste), *taglioni* (It. for slices), *fanti*, and other names. Macaroni is dried rapidly by hanging it in long strands over wooden rods in rooms through which passes a current of heated air. It is only genuine macaroni rich in gluten which can be properly dried in this way, for preparations of common wheat deficient in gluten are correspondingly poor in tenacity and break under their own weight. Accordingly, genuine macaroni is easily recognized by the flattening of the sticks or tubes at the bends, whereas imitations have to be laid out to dry on tables and dried more slowly, with the alternative result that they crack or split, or else turn mouldy inside. The genuine product should be pale-yellow, slightly elastic, yet hard, and showing when broken a smooth, glossy, conchoidal fracture. In boiling water it swells up to twice its original bulk without becoming sticky or pasty, maintaining its tubular form without either flattening or bursting. Owing to its greater richness in gluten, macaroni keeps indefinitely, while its hard, glossy surface resists the attacks of insects. Ordinary soft wheaten flour of the American type may be enriched with gluten derived from wheaten starch, and then ground up into a paste as before. Borland, a Parisian baker, has invented an instrument called the aleurometer, by which the proportion of gluten is estimated in terms of tenacity and breaking pull.

The following analyses, made by the United States Department of Agriculture, show the most recent figures with regard to macaroni and similar wheat preparations:—

	Refuse.	Water.	Proteids.	Fat.	Total Carbohydrates.	Cellulose.	Ash.	Full Value (Calories) per lb
Macaroni, minimum ..	—	7·0	7·9	—	67·2	—	0·3	1540
„ maximum ...	—	12·3	16·6	4·9	78·4	—	7·0	1775
„ average ..	—	10·3	13·4	0·9	74·1	--	1·3	1665
Macaroni, cooked ...	—	78·4	3·0	1·5	15·8	—	1·3	415
Spaghetti, average ..	—	10·6	12·1	0·4	76·3	0·4	0·6	1660
Vermicelli, „ ..	—	11·0	10·9	2·0	72·0	—	4·1	1625
'Noodles' „ ...	—	10·7	11·7	1·0	75·6	0·4	1·0	1665

The fuel value of average winter wheat flour is 1650.

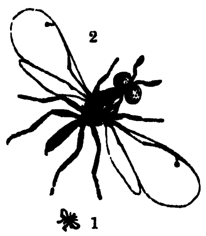
Macaroni is largely used in soups and for puddings with cheese and other substances which are rich in fat and proteids. Indeed, in Genoa the name was originally given to little balls made of paste and powdered cheese. Genoa is still the great centre of the Italian industry, both for home and export trade. [J. K.]

M'Combie, William, of Tillyfour (1805–1880).—References to some of the principal results achieved by this famous breeder of polled animals are made in the article on ABERDEEN-ANGUS CATTLE. M'Combie was born on his father's small estate of Tillyfour in Aberdeenshire. The elder M'Combie was an enterprising cattle dealer with a liking for the hum'led or polled stock of his country side. At an Aberdeen banquet held in his honour in 1862, William M'Combie said, in replying to the toast of his health: 'I was led by a father whose memory I revere, to believe that

our polled cattle were peculiarly suited to our soil and climate, and that, if their properties were rightly brought out, they would equal, if not surpass, any other breed as to weight, symmetry, and quality of flesh. I resolved that I would endeavour to improve our native breed.' After finishing his school course, young M'Combie began to deal in cattle, and by the time he reached man's estate he was noted for his rapidity and accuracy of judgment. In or about 1829 he began to farm Tillyfour on his own account. By 1830 he had laid the foundation of a polled herd. When his great herd was dispersed in 1880, seventy animals averaged £48, 1*s.* 6*d.*, the leading figure of 270 gs. being paid by Mr. R. C. Auld, Bridgend, for Pride of Aberdeen 9th (3253). M'Combie will be chiefly remembered as evolver of the Pride of Aberdeen family, and as phenomenal winner at the breeding and fat-stock shows. As an exhibitor he was often amusingly diplomatic, but in selecting breeding animals from other herds he showed no prejudices. Many pages of his entertaining volume Cattle and Cattle Breeders (Blackwood & Sons) deal with his successes at home and foreign exhibitions. At the Royal Northern Agricultural Society, Aberdeen, the 'M'Combie Prize', the result of public subscriptions, has commemorated since 1878 the work and aims of the great breeder. M'Combie was M.P. for his county from 1868 to 1876. [J. CA.]

M'Cormick, Robert (1780–1846).—The name of M'Cormick is as inseparably associated with the evolution of harvesting machinery in the United States as is that of his contemporary, the Rev. Patrick Bell, in Britain. For M'Cormick has been claimed the honour of having invented the prototype of the modern reaper. Some doubt exists as to whether or not this is actually the case. American invention of grain-cutting machinery seems to have begun in 1803, and several patents were granted in the decade immediately succeeding. M'Cormick is said to have invented his first machine in 1809, and continued to improve upon his first essay until about 1830, when, in conjunction with his son Cyrus H. M'Cormick, he invented and applied to his machine what is known as the vibrating sickle and horizontal reel. He secured a patent for this improved machine in 1834, although it has since been alleged that the horizontal reel in question did not constitute a new improvement. Whatever doubt may exist as to the invention itself, there can be none on the influence of Robert M'Cormick, and later of his sons Cyrus, William, and Leander, in the gradual extension of the use of harvesters in America and elsewhere. Out of their combined efforts grew the M'Cormick Harvesting Machine Company, and the M'Cormick Harvester still maintains a prominent place in all countries where self-binding machinery is in requisition. [J. B.]

Macroglenes penetrans is one of the parasites which lays its eggs in the larvæ of the wheat midge, *Diplosis tritici*, in June, by piercing the florets of the wheat with its little ovipositor. The male is shining bottle-green, antennæ black, short, and clubbed, basal segment very long; head large, with very large, orbicular, reddish-brown eyes; thorax oval and uneven; body compressed like the blade of a knife; wings very transparent, upper large, with a minute clubbed branch on the costa; legs simple, feet white, dark at the tips; female with shorter antennæ, the club large; eyes not large, oval, brown, and far apart; apex of body truncated, the ovipositor projecting. [J. C.] [F. V. T.]



Macroglenes penetrans
1, Nat. size; 2, magnified.

Macrophya punctum album (the Privet Sawfly).—This sawfly has small, quite green larvæ which are often found on privet, and sometimes do considerable damage in garden hedges. The larvæ are noticed in July, and ravenously eat the epidermis of the leaves and cause them to shrivel up. They pupate in parchment-like cocoons. The sawfly is shiny-black with yellowish-white marks on the thorax; the black abdomen has white lateral spots, and one on the last segment in the female, whilst in the male it is all black. The first two pair of legs are dark with pale areas; hind femora almost red, the tibiæ with a broad apical white band. Length, $\frac{1}{4}$ to $\frac{1}{3}$ in. They may easily be destroyed by spraying with arsenate of lead. [F. V. T.]

Madar, or **Ak** (*Calotropis gigantea*, R. Br., Asclepiadeæ), the Swallow-wort, an exceedingly abundant wild plant met with in most tropical countries, more especially India. It yields two useful fibres—one the floss of its seeds, the other separated from its bark. It moreover also affords a poor quality of gutta-percha, and the root bark has a reputation as a domestic medicine in the treatment of dysentery and of intermittent fever.

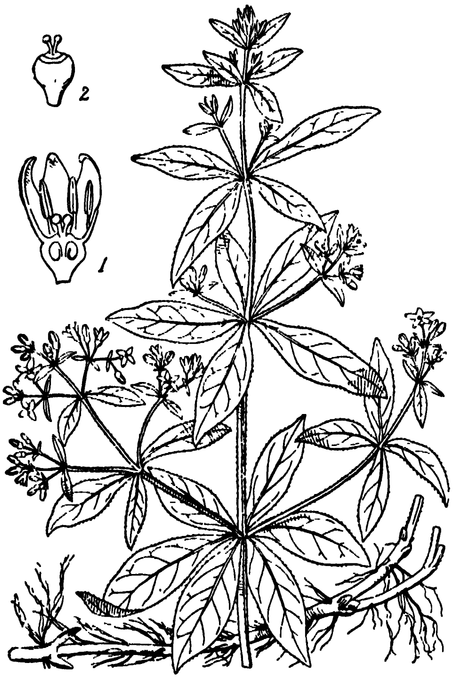
The silk-cotton or floss of the seeds is largely used for upholstery, and in India is to some extent spun and made into fishing lines and nets, and even woven into rugs. In former years cloth made of this floss (often called by its South Indian name *yercum*) was largely used, and is spoken of by early Anglo-Indian writers as 'grass cloth', 'cloth of herbes', &c. The bast fibre, on the other hand, has recently attracted much attention, and been described as one of the best of Indian fibres. The chief obstacles to an extended utilization are the difficulty in separating and cleaning, and the consequent cost of production. In fineness, tenacity, lustre, and softness it has few equals, and is almost fit for any industrial purpose. [G. W.]

Madder, a perennial plant formerly extensively cultivated for the rich red dyestuff, alizarin, yielded by its roots.

Madder belongs to the nat. ord. Rubiaceæ, an order which includes the Bedstraws and Goosegrass or Cleavers. It is a native of Italy, Greece, and parts of western Asia; and large tracts of land in France, Germany, Greece, and Turkey were at one time utilized for its growth. Since the artificial synthesis of alizarin in 1868 by Graebe and Liebermann, the cultivation of Madder has, however, diminished enormously.

The roots are long and succulent, about ⅓ in. thick, and descend 2 or 3 ft. into the soil. The stems are herbaceous, quadrangular, more or less trailing in habit, and covered with harsh hooklike projections similar to those on Cleavers. They die down annually. The leaves grow in whorls, five or six together at each joint, and are narrow and lanceolate, with prickly margins. The flowers are arranged in axillary cymes, and have small bell-shaped, yellowish corollas. The fruit is a dark-purple berry about the size of a pea.

The colouring matter obtained from the roots



Madder (*Rubia tinctorum*)
1, Section of Flower. 2, Pistil.

consists chiefly of the 'turkey-red' alizarin, along with a small amount of purpurin and a yellow substance, xanthine. The former alone is of value to the dyer. The tinctorial materials are not present in the roots when the latter are taken from the soil, but are produced by the oxygen of the air, or by the action of special ferments upon certain compounds, the chief of which is the glucoside, ruberythric acid.

Madder grows best in friable, well-drained soils rich in humus, or on light land which is in good condition. It needs a warm, bright climate for the production of the greatest amount of the red colouring matter.

The crop may be raised from seeds sown in March, or from 'sets' obtained from division of the rootstocks, the latter being the plan generally adopted for propagation of the plant.

The land must be clean, deeply cultivated, and at first well supplied with readily available fertilizers or manures. A dressing of dung before ploughing in autumn is useful.

The 'sets' are planted in April in rows 18 to 24 in. apart and 9 to 12 in. asunder in the rows. Seedlings raised in special beds may be used also for planting out. During growth the crop must be kept clear of weeds by hoeing, and allowed to grow freely for three or four seasons, or in some countries as long as six years. At the end of this time the plants are dug up in September and the soil carefully shaken from the roots, the haulm or stems above-ground having previously been cut off with a scythe or other implement. The roots are then allowed to dry in the open air where the temperature and climate are suitable, or dried artificially in specially constructed kilns or stoves. Further cleaning to get rid of all the soil is necessary, after which the roots are packed in bags for sale, or ground into fine powder and sent to the market. From ½ to 1 ton per acre is the usual yield. [J. P.]

Madness. See RABIES.

Maggot.—The early or larval stage of certain insects is termed the maggot state; it is a general term applied as a rule to the legless type of larvæ such as we find in the Blowfly, Cheese Hopper, certain bees, and several internal feeders such as the Carrot Fly, as well as various leaf miners. The sheep maggot is described in the art. SHEEP MAGGOT FLY; the cheese maggot under the title PIOPHILA CASEI. [J. J. F. X. K.]

Maggots, Treatment for.—Open sores in animals, that would in the course of a few days heal by suppuration and granulation (see WOUNDS), are frequently poisoned by flies, and filled with maggots by the deposition of the larvæ of the *Sarcophagus carnaria*—a fly closely resembling the well-known 'bluebottle', but on close examination showing black speckles on the abdomen. All the flies of this tribe are attracted by the smell of wounds or of decomposing flesh; and it has been demonstrated by Dr. Forel, in a series of most interesting experiments, that the Sarcophagidæ (most of which are viviparous) are not to be deterred from seeking their natural food, or ovipositing when satisfied, by having previously had their eyes removed by a razor. The *Sarcophagus magnifica* and others, thus deprived of sight, will fly against solid objects and fall; but when put near decaying flesh, make their way promptly to it, presumably by the sense of smell, discover a breach, and gorge themselves; then recurving the ovipositor, proceed to the business of reproduction. The habits of this species lead to great suffering on the part of animals, and to much loss by cattle and sheep farmers. Broken horns or wounds about the head may be flyblown, and the maggots resulting fill the horn cores and get into the sinuses of the skull, and sometimes cause death. There is scarcely any situation where the victim can protect himself from the fly bent on depositing her larvæ; and we find fistulous withers and feet with quittors flyblown in horses turned out to grass in summer; and cattle with foul or kibe have their prospects of recovery ruined by the filling up of the injured structures with a mass of writhing maggots. Sheep are the greatest of all victims to maggots, the fly seeking industriously for a wound however small, one perhaps caused by the bite of a tick or other enemy,

and being specially attracted to such festers as occur under the tail when 'scour' or diarrhœa has resulted in a decomposing mass and attached the tail to the perineum. The effect of such a plaster is to excite suppuration, and this is the fly's opportunity. There are districts comparatively free from fly, and others where precautions must be taken every season. Under trees, and in moist low-lying places, flocks should be protected in the hot months by parting the fleece and dusting on a fly powder such as the following, choosing a dewy morning, or sprinkling some water from a pot provided with a fine rose: white lead, 2 lb.; red lead, 1 lb.; sulphur flowers, 1½ lb.; spirit of tar, 4 oz. The leads are rubbed down with the tar spirit, and the dry powders incorporated by further trituration in a mortar. A flour dredger is a suitable distributor. This mixture enjoys a great reputation as a preventive of maggots, flies being deterred from settling on a sheep thus protected. When maggots are found upon a sheep they may be destroyed without injury to the pelt by a mixture of 1 part carbolic acid and 10 to 15 of seed oil. Shepherds use 'fly stone' (perchloride of mercury), which is most effectual, but leaves the skin injured permanently from the tanner's point of view. Wounds should be injected with the above carbolic lotion by means of a syringe. [H. L.]

Magnesia and Magnesian Compounds.—Magnesia is an oxide of the metal magnesium. It is formed when the metal is burnt in air. On a commercial scale it is manufactured by prolonged heating of the carbonate of magnesium, or by ignition of the hydrate. Enormous quantities of magnesium salts are found along with salts of the alkali metals at Stassfurt in Germany. In the purification of the potash salts, the salts of magnesium are obtained as by-products; from these, after conversion into the carbonate, much of the magnesia is made. The magnesia of commerce is a white amorphous bulky powder, with a specific gravity about 3·15. It is known as *magnesia usta* or calcined magnesia. Magnesia can, however, be obtained in a crystalline form. It fuses at the temperature of the oxyhydrogen flame, and solidifies into a hard vitreous mass which will scratch glass. It is almost insoluble in water, alkaline to litmus, but not very caustic. Magnesia, because of its infusibility, is used in the manufacture of crucibles, firebricks, cupels, &c. It also possesses medicinal properties. It absorbs carbon dioxide slower than quicklime, and thus remains caustic longer than the latter; for this reason it is not advisable to use ground lime containing magnesia as a manure, because of the injurious caustic action of magnesia upon plants. The element magnesium occurs in the ash of all plants and forms one of the essential constituents of their mineral food. Unlike phosphates, potash, nitrogen, and lime, it is generally found in sufficient quantities in ordinary soils to meet the full requirements of crops. For this reason magnesium salts have not hitherto been employed as manures. However, in recent experiments on nitrification in which the carbonate of magnesium has been substituted for chalk, it is found to have just the same useful and beneficial action on the growth of the nitrifying organism as chalk had; and moreover, an experiment recently carried out at the Royal Agricultural Society's farm at Woburn, in which the application of 3 and 6 cwt. per acre of magnesia to potatoes produced an increase of 13 cwt. and 1 ton 5 cwt. respectively. The only other manure applied was a nitrogenous manure. This is quite a remarkable result in view of the generally accepted opinion hitherto held, that it was unnecessary to apply magnesium salts to a soil as manure, but more experiments and information are needed before any revision is made of our ideas of the usefulness or otherwise of magnesium salts as manures. Enormous deposits of magnesium salts occur at Stassfurt in Germany along with the salts of sodium and potassium. Sulphate and chloride of magnesium form the larger proportion of the manure kainit.

The following are some of the principal salts of magnesium: *magnesium carbonate* or magnesite. The mineral dolomite is a mixture of calcium and magnesium carbonate, and occurs abundantly distributed (see DOLOMITE). There are two forms of the commercial carbonate: *magnesia alba levis* and *magnesia alba ponderosa*. The former is a light bulky powder, and the latter much denser. On heating them, a light and a heavy form of the oxide is obtained. *Magnesium sulphate* (Epsom salts) is obtained mostly from the Stassfurt deposits. It can also be made by the action of sulphuric acid upon the carbonate. It is a crystalline salt soluble in water, and possesses valuable medicinal properties. It forms the purgative principle in bitter spring waters. Magnesium salts are used for warp-sizing cotton and in dyeing with aniline dyes. *Magnesium citrate* is a mild purgative. [R. A. B.]

Magnesian Limestone. See art. DOLOMITE.

Magnetite, the black oxide of iron, Fe_3O_4, which attracts iron and its own powder. When occurring in large quantities in rocks, it deflects the magnetic needles of mariners and surveyors. Hence it is also styled *Lodestone*. It crystallizes in iron-grey octahedra, too hard to be scratched by a knife. It occurs abundantly as small grains in basalts, gabbros, and similar igneous rocks, and in some schists. It alters into limonite, colouring the decomposed rock brown. [G. A. J. C.]

Magnolia, ornamental hardy or greenhouse evergreen or deciduous trees or shrubs, natives of China, Japan, the Himalayas, and North America (nat. ord. Magnoliaceæ). Generally speaking, those that are tall trees are of American, and the more dwarf species of Asiatic origin. They are certainly among the most attractive of all hardy trees and shrubs, the flowers being large and conspicuous, and most of them very fragrant. Several of the best sorts flower in early spring, and are thus very liable to be marred by inclement weather. *M. stellata* is often brought on early under glass. Magnolias require a deep and moderately rich soil, and in the north should be given a sheltered position. They are difficult to transplant; this operation

requiring to be performed with great care, and March, April, and September are the best months for it. They are increased by layers and by seeds, and by grafting in July and August. The following are the most popular sorts: *M. acuminata* (Cucumber Tree), yellowish flowers, grows very large, and is one of the hardiest; *M. conspicua* (Yulan), a large shrub or small tree producing an abundance of large white fragrant flowers in early spring; *M. grandiflora* (Bull Bay), an evergreen with large, shining leaves, and immense fragrant flowers produced in summer, often planted against dwelling-houses; *M. parviflora* and *M. Watsoni*, both white flowers with red stamens produced in summer, of recent introduction; *M. Soulangeana* (*conspicua* + *obovata*), white flowers tinged with rosy-purple; *M. stellata*, a dwarf shrub, with star-shaped white flowers produced in remarkable abundance in early spring. This species appears to great advantage when grown in beds. [W. W.]

Magpie (*Pica rustica*).—This piebald member of the crow family is about 18 in. long, including the 10-in. tail. Shoulders and belly are white, and the rump grey, while the rest of the plumage is glossy black, shot with green and blue. The large domed nest is built in a tall hedge, or a hedgerow tree. It is strongly made of thorny twigs and moss, plastered internally with clay, this again being thickly lined with grass. The six to nine pale-green eggs are spotted or blotched with olive-brown. Magpies chiefly feed on worms, snails, and mice, and sometimes on young rats or carrion. They also devour the eggs and young of other birds. To agriculture pure and simple the species is decidedly beneficial, but those specially interested in poultry or game are justified in keeping down its numbers. [J. R. A. D.]

Magpie Moth, a creamy-white moth, spotted and banded with black and yellow, whose larvæ do much damage to the leaves, buds, and young foliage of currant, gooseberry, and other trees. See ABRAXAS GROSSULARIATA.

Mahogany Tree (*Swietenia Mahagoni*) is the sole species of a genus of the Meliaceæ family. The Meliaceæ comprise many genera indigenous to tropical and subtropical latitudes throughout Asia and America, and the Mahogany tree has its habitat in Central America and the Antilles. Its dark-red, beautifully grained, and finely flowered wood, hard and durable, was first imported into Britain from Jamaica in 1753, and soon displaced oak and elm to a considerable extent as furniture woods. Like most of the Meliaceæ it is a tree with imparipinnate leaves, and has bright-green shiny leaflets. Its inflorescence consists of panicles of small pentamerous flowers with ten monadelphous stamens; and its fruit is a brown pear-shaped woody capsule which opens to shed numerous soft, flattened, short-winged seeds. The Mahogany tree grows best within the influence of the sea air, and has long been cultivated with a fair amount of success in India (Calcutta, Akyab, Rangoon), where a large-leaved variety (*S.M. macrophylla*) has been produced at the Calcutta botanical gardens. The fruits of the Mahogany tree should be collected in March before the capsules burst, and each seed should be sown in a loosely woven basket or a flower-pot, which should be cut or broken at time of planting, so as to avoid creating any physiological disturbance. Two trees which grew in the writer's garden at Akyab (Burma) girthed 5 ft. 5 in. and 5 ft. 7 in. in 1881, when about fifty to fifty-five years of age, but were short in the bole and of branching habit. In the timber trade various kinds of mahogany are distinguished, the chief being Spanish, Cuba, and Honduras mahogany or Baywood. Spanish mahogany, originally supplied chiefly from San Domingo, is the richest in colour and figure, and the most valuable for furniture and veneering; but when supplies of it gradually became exhausted, its place was mainly taken by Cuba mahogany, of larger dimensions and little inferior as ornamental wood. Honduras mahogany is also of large size, though less richly figured, and especially if grown on the low-lying swamp lands. But the largest logs are obtained from Mexico, although these, too, are usually less ornamental than the Spanish and Cuban mahogany. Our imports of mahogany are chiefly obtained from Mexico. [J. N.]

Mahua (Mowha), *Bassia latifolia*, Roxb., and *B. longifolia*, Linn., Sapotaceæ. The former may be spoken of as the *mahua* of northern India, and the latter the *illupei* of southern India. Though met with in several localities in a purely wild condition, these trees mostly exist in a state of semi-cultivation. They prefer dry, sandy, and even rocky soils to rich low-lying and inundated lands. So exceedingly valuable are they, to the country where they are at all prevalent, that few schemes of famine protection could be more confidently commended than the extended production of *mahua* and *illupei* in all tracts of land where their cultivation is at all possible. The flowers are edible, and the seeds afford a most useful oil.

The clusters of cream-coloured flowers adorn the twigs of the naked trees, just before the bursting forth of their fresh garb of foliage in February to April. The ground below the trees is cleared of all weeds and smoothed over. From March onward to the end of April a shower of flowers takes place daily, in the early morning. Each individual tree completes its contribution in about eight to ten days, and yields from 1½ to 3½ cwt. The flowers are swept up and carried off to a drying ground, where they are exposed to the sun and turned over daily till quite dry. They shrink in size and change in colour to a dark-reddish brown, and become (to the European) offensively scented. They are then conveyed to the homestead and stored as human or cattle food, or are exported to Europe. Some conception of the magnitude of this source of wild food may be accepted when it is stated that in the Central Provinces of India alone it has been ascertained that 1,400,000 persons use *mahua* as a regular article of food, and each consumes about 1 cwt. per annum. The flowers are beaten with a stick to free them of the stamens and other impurities, then boiled for six hours and allowed to simmer on the fire

until all the water is expelled and the mass of flowers reduced to a soft, juicy, and very sweet pulp. It is, in fact, extremely sweet, and the power to digest such food is an acquired one that no European has yet attained. Mahua is at times so abundant that 1 cwt. may often be purchased for 12 annas (one shilling). The surplus over local consumption is sold, and the chief purchasers are the distillers, and the additional revenue thus obtained by Government greatly enhances the value of the crop. Some years ago there was a fairly brisk trade in exporting *mahua*, which went mainly to France to be used (so it was believed) in distillation. But the French ports were soon closed to *mahua*, and the trade was discontinued, except the small traffic that still exists in exporting to Europe the dried flowers to be employed in fattening pigs.

The seeds yield a valuable oil and also a butter. From the remotest antiquity *mahua* butter has been known, and that obtained from the species *B. butyracea* is supposed to be superior to that of the other two plants discussed above. The seeds are generally known in trade as *mohoti*, and are collected about May to June. They are said to cost Rs4½ per cwt. The exports in these seeds stand at present at about half a million cwt., and they are consigned mainly to Hamburg and Antwerp. The oil expressed in India from these seeds is greenish-yellow, is largely eaten, and much used to adulterate *ghi* (clarified butter). In south India the solid form (butter) is produced. Here and there a fair amount of the oil is made into soap, and apparently the only limitation to its production and use is the apathy of the people to extended enterprise. [G. W.]

Maidenhair.—The Maidenhairs (Adiantum, nat. ord. Filices) are a large genus of very handsome tropical and temperate ferns particularly well adapted for growing in gardens. The American *A. pedatum* is the only species which is perfectly hardy, for, as a severe frost will kill it, our native *A. Capillus-Veneris* (Venus's Hair) cannot rightly be termed so. It is rare, being now confined to a few remote places, principally on the south-west coast, and in Ireland. There are a number of striking distinct varieties of this plant. The species most commonly cultivated in greenhouses is *A. cuneatum*, a native of Brazil, introduced about ninety years ago. This and some of the others are cultivated on a very extensive scale by market gardeners, the fronds being used to make up buttonholes, sprays, bouquets, &c., though of late years it has had a more formidable rival in asparagus fronds than used to be the case. *A. Farleyense* (see fig.), a native of Barbados, which has very broad pinnæ, forming brilliant-green, gracefully drooping fronds 1 to 3 ft. long, is the noblest member of the genus. It is a remarkably fine pot-plant, and the fronds are very useful as foliage for cut flowers of a large size. Other particularly good greenhouse maidenhairs with large fronds are *A. cardiochlæna* and *A. polyphyllum*. Maidenhairs require a compost of peat or leaf mould, loam, and silver sand, with good drainage and regular pottings-on, while much overhead watering is injurious to them. They are easily propagated from spores sown early in the year or by division. [W. W.]

Maidenhair Tree, a rather quaint and beautiful tree whose leaves resemble the magnified leaflets of the Maidenhair Fern. See GINGKO.

Maiming Cattle.—The word 'maim', or as it appears in English legal phraseology 'mayhem', means bodily injury done to a man whereby he is deprived of any member of his body so as to incapacitate him from military service.

In England, by the Malicious Damage Act, 1861 (which does not apply to Scotland), the malicious killing, maiming, or wounding of any cattle, including horses, asses, and pigs, is a felony, and anyone convicted thereof is liable to be kept in penal servitude for not more than fourteen years. By the same Act it is provided that malicious killing, maiming, or wounding any dog, bird, beast, or other animal not being cattle, which is the subject of larceny, subjects the offender to a term of imprisonment not exceeding six months, or a fine not exceeding £20 (over and above the damage done) for a first offence, and to imprisonment not exceeding twelve months for any subsequent offence.

To constitute maiming in the meaning of the Act a permanent injury must be inflicted on the animal, although the injury is not necessarily external. Wounding means an injury which must be external, but not necessarily permanent.

In Scotland, maiming of cattle was at an early date made a criminal offence by the Statutes of 1581 and 1587. By the former Act it was declared that all 'slayeris and houcheris of horses and oxen or outher cattel in time cumming sall be esteemed and punished as thieves', and that both the committers of the offence and all who harbour them were on conviction to incur the pain of death, and confiscation of all their moveable goods. These Acts were repealed by the Statute Law Revision (Scotland) Act of 1906; but the killing, maiming, or wounding cattle is punishable as malicious mischief.

The above statement of law refers only to animals ordinarily kept in confinement, or for any domestic purpose, and would not apply to injuries done to animals by their owner. In such cases, action would be taken under the Acts for the Prevention of Cruelty to Animals. See ANIMALS, LAWS REGARDING. [D. B.]

Maize (*Zea Mays*) is divided into six species-groups by Dr. E. L. Sturtevant[1] as follows:—

1. *Zea indentata* (the Dent Corns).—The corneous endosperm is at the sides of the kernels, while the starchy endosperm reaches to the summit. In the process of the drying out of the starchy endosperm the summit of the kernel is drawn in, and in this manner the tops of the kernels become indented in various ways. The kernels are long, angular, and usually fit closely together on the cob. The ears are large, bear a comparatively large number of rows of kernels, and a large number of kernels in the row. The dent corn is the principal corn grown in the United States, and is of prime importance in the corn production of the world.

[1] Bulletin No. 57 of the U.S. Department of Agriculture.

2. *Zea amylacea* (the Soft Corns). — This species-group is distinguished by the absence of corneous endosperm, and through the uniform shrinking of the starchy endosperm there is little or no indentation of the kernels. The soft corns are grown extensively in Central and South America and in other countries of southern latitude.

3. *Zea indurata* (the Flint Corns).—In the flint corns the corneous endosperm of the kernels encloses the starchy endosperm, and the kernels are smooth, of flinty appearance. There are usually from eight to twelve rows of kernels on the cob, the kernels being very shallow, and the seed early in maturity. The flint corns are grown in northern latitudes, having short seasons, but their place is rapidly being supplanted by dent corns bred for early maturity.

4. *Zea saccharata* (the Sweet Corns). — The kernels of the sweet corns are translucent, very wrinkled and shrivelled in appearance. They are the principal corn of the northern United States grown for table use both as roasting ears and for canning purposes. The corn is very high in sugar content, and the texture of the kernels in the milk stage is very tender. It is probably of American origin, having been discovered by the early explorers in the United States in cultivation by the Indians.

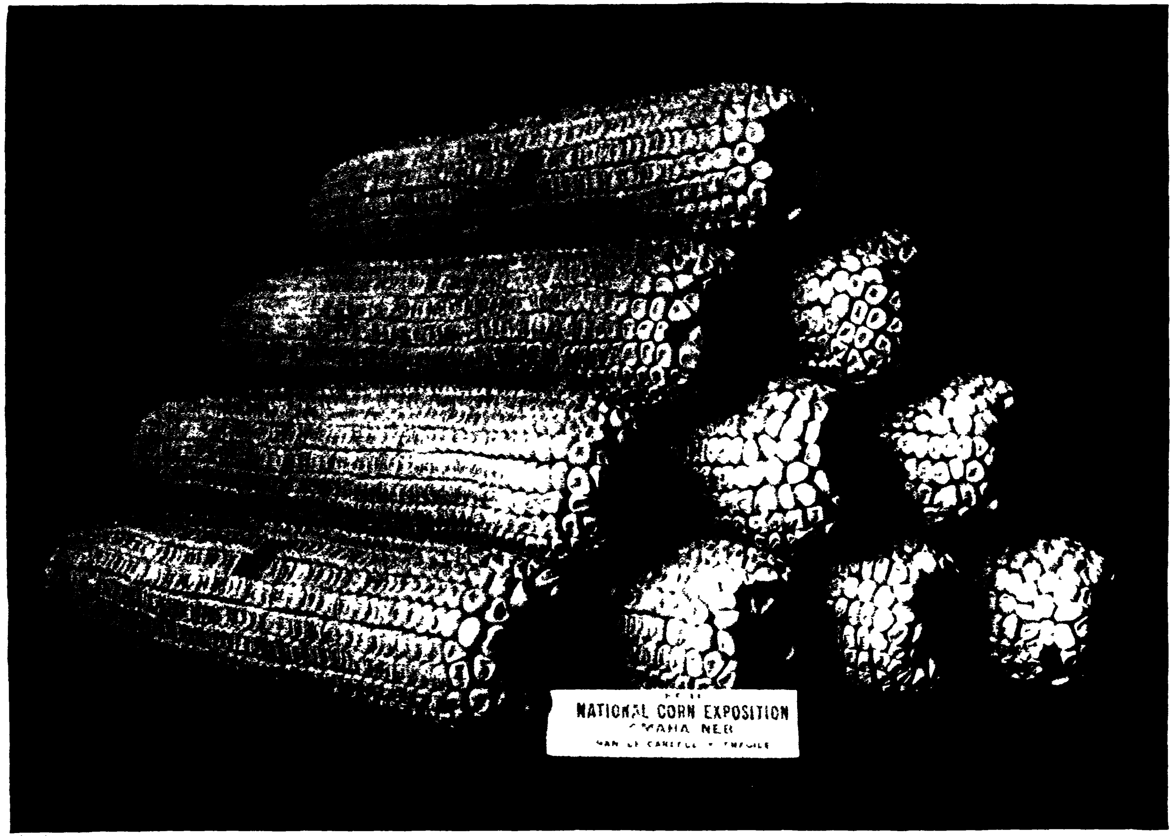
5. *Zea everata* (the Pop Corns). — The popcorn kernels have a large proportion of corneous endosperm, and when dried and heated under proper conditions, turn inside out, probably through the explosion of the moisture contained in the kernels. The ears, kernels, and plants are usually small, and are cultivated for popping purposes only; but in some countries, as Austria, this corn is grown for animal food as well as for human use. The plants and seed are hardy, being resistant to unfavourable conditions such as drought, insufficient rainfall, and low temperature.

6. *Zea tunicata* (the Pod Corn).—The kernels of this species-group are enclosed in pods or husks, and the ears may be enclosed in a general covering or husk. In the cultivation of dent corn, ears of pod corn occasionally appear in the fields, which come fairly true to seed when planted. The kernels are usually small, flinty, and the ears and kernels vary greatly in their physical characteristics. It is not a corn of commerce, but is grown to a limited extent in southern latitudes, where it is claimed to be immune to certain insect attacks.

According to Harshberger the word *Zea* is probably derived from the Greek words ζάω, 'I live', or ζεά, 'spelt'; while the word *maize* is an Arawak word, and is derived from the Haytian word *mahiz*, which Columbus adopted when in Hayti. Botanists now use *Zea Mays* to indicate Indian corn, an annual herbaceous plant belonging to the grass family Gramineæ. When Columbus landed in the New World he found the natives cultivating a new cereal, specimens of which he took back to Spain. The early explorers naturally extended to this new grain the term 'corn', which comprehends all kinds of grain, and limited its use by the prefix 'Indian'. In the United States Indian corn is called simply corn.

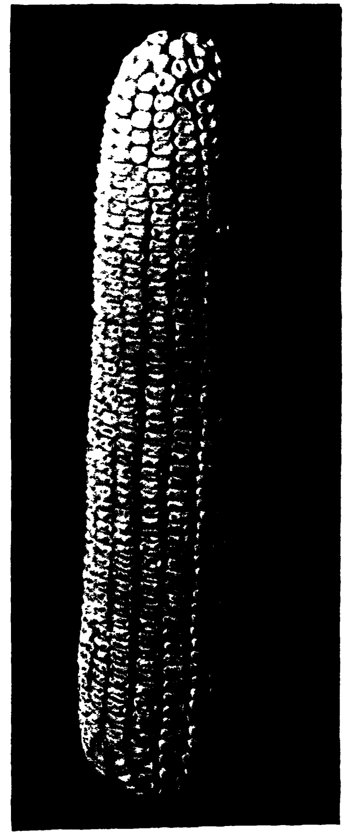
The early explorers in America found the Indians cultivating in a crude way Indian corn. The crop entered into the mythological and religious ceremonies of the natives in both North and South America. It was the principal source of food cultivated by the Indians; and the methods of culture, selection of seed, and conversion of the seed into articles for human food were taught the explorers and colonists by the Indians. In cultivating the crop, the Indians deadened the timber by girdling the trees with stone axes or by burning, and in the spring the Indian squaws made holes in the ground about 4 ft. apart, dropped the seed in the holes, and covered the kernels with soil. In some regions the culture of corn had reached such a stage of progress that fish were used to fertilize the soil, and the land was roughly stirred with stone hoe-like implements in order to promote the growth of the crop. The ears were harvested and stored in pits or storehouses. The first attempt to cultivate corn by the English settlers, so far as known, was about 1607 or 1608 at Jamestown, Va., and about 1621 in Massachusetts. Its culture developed rapidly, and as early as 1650 it is recorded that considerable quantities of corn were exported to England by the colonists. On the discovery and settlement of the fertile prairie lands of the Mississippi valley, which were found to be particularly suitable to corn culture, the increase in the amount of production became tremendous, until now this great valley is the chief centre of corn production in the world. It is here, too, that the greatest advances have been made in the invention of machinery for the cultivation and harvesting of the crop, the production of improved varieties, and the development of methods for utilizing the product. The extent of the production of corn in the different countries of the world, the methods of culture, breeding, and uses of the corn crop, will be briefly outlined in the following pages.

The production of corn in the corn-producing countries of the world, 1902–6, as given in the Agricultural Statistics for 1907, in the Yearbook of the United States Department of Agriculture, is as shown in table on p. 149. This table shows that the great bulk of the corn crop of the world is produced in North America, particularly the United States. Europe is second so far as amount of production is concerned, while the amount of corn produced by all the other countries of the world is comparatively small. Roumania and the Argentine Republic are two corn-growing countries where the increase in the production of corn has been remarkable during the past decade. The great undeveloped areas in the Argentine suitable for corn culture make it possible that this country may soon become one of the leading corn-producing countries in the world. As a result of extensive experiments by the British Government in South Africa in the culture of corn in the Transvaal, Rhodesia, Cape Colony, and other colonies, it is predicted that this region may become an extensive corn-producing area. In the United



(123)

GROUP OF THE BEST TEN EARS OF WHITE DENT CORN (MAIZE)
EXHIBITED AT THE NATIONAL CORN EXPOSITION, OMAHA, NEBRASKA, 1908



THE BEST SINGLE EAR OF WHITE
DENT CORN (MAIZE) AT THE EXPOSITION

Country.	1902.	1903.	1904.	1905.	1906.
North America—	bushels.	bushels.	bushels.	bushels.	bushels.
United States	2,523,648,000	2,244,177,000	2,467,481,000	2,707,994,000	2,927,416,000
Canada (Ontario) ...	21,159,000	30,211,000	20,880,000	21,582,000	24,745,000
Mexico	78,099,000	90,879,000	88,131,000	85,000,000	70,000,000
Total North America..	2,622,906,000	2,365,267,000	2,576,492,000	2,814,576,000	3,022,161,000
South America—					
Argentina	84,018,000	148,948,000	175,189,000	140,708,000	194,912,000
Chile	866,000	1,118,000	1,477,000	1,244,000	846,000
Uruguay	5,060,000	5,289,000	3,035,000	4,417,000	3,226,000
Total South America...	89,944,000	155,355,000	179,701,000	146,369,000	198,984,000
Europe—					
Austria...	13,462,000	16,056,000	12,529,000	17,293,000	18,177,000
Hungary (proper) ...	104,546,000	135,751,000	59,400,000	94,045,000	162,923,000
Croatia-Slavonia ...	15,255,000	23,766,000	11,364,000	18,385,000	25,600,000
Bosnia-Herzegovina ...	5,863,000	8,411,000	6,464,000	9,584,000	8,936,000
Total Austria-Hungary	139,126,000	183,994,000	89,757,000	139,307,000	215,636,000
Bulgaria	18,100,000	22,836,000	12,758,000	19,649,000	20,000,000
France	24,928,000	25,360,000	19,482,000	24,030,000	14,581,000
Italy	71,028,000	88,990,000	90,545,000	97,265,000	93,007,000
Portugal	16,000,000	14,000,000	15,000,000	16,000,000	16,000,000
Roumania	68,447,000	80,272,000	19,598,000	59,275,000	130,546,000
Russia (European) ...	48,419,000	50,464,000	25,920,000	33,331,000	70,501,000
Servia	18,396,000	19,479,000	9,498,000	21,431,000	27,786,000
Spain	25,272,000	18,759,000	21,300,000	31,880,000	30,000,000
Total Europe ..	429,716,000	504,154,000	303,858,000	442,168,000	618,057,000
Africa	36,899,000	36,118,000	38,862,000	37,655,000	37,700,000
Australasia	7,846,000	5,614,000	10,519,000	8,880,000	9,261,000
Grand total	3,187,311,000	3,066,508,000	3,109,432,000	3,449,648,000	3,886,163,000

States nearly all of the land suitable for corn culture has been occupied, so that it is improbable that there will be any great increase in production in this country due to increase of the area now producing corn. A marked increase in total production in the United States is being effected, however, by the use of higher yielding varieties of corn by the corn growers.

The production of corn in the different States in the United States commonly known as the 'corn belt' of the United States, and mostly lying in the Mississippi valley, is shown in the following interesting table. The figures show the average acres cultivated in the respective States, and the average yields per acre for ten years, viz. 1898 to 1907 inclusive. The total yields can easily be determined from these figures.

ACREAGE AND YIELD PER ACRE OF LEADING CORN-GROWING STATES IN UNITED STATES, 1898 TO 1907 INCLUSIVE.

State.	Acreage.	Bushels per Acre
Iowa	8,652,208	32·54
Illinois ...	8,593,229	34·37
Nebraska ...	7,664,271	22·11
Kansas ...	7,495,991	22·49
Missouri ...	6,493,259	28·48
Texas	5,672,266	19·28
Indiana ...	4,308,329	35·07
Ohio	3,043,702	35 12
Tennessee ...	3,097,349	22·93
Arkansas ...	2,326,209	18·90
Mississippi ...	2,220,778	15·47
Oklahoma ...	1,759,307	23·57
Wisconsin ...	1,380,000	33·54
Colorado ...	1,305,000	20·31
Minnesota ...	1,331,543	29·54
Michigan ...	1,298,973	31·91

From this table it will be seen that the great corn-producing States in the United States are Iowa, Illinois, Nebraska, Kansas, Missouri, Texas, Indiana, and Ohio.

The production of corn in the United States has increased enormously in the past quarter of a century, as is shown in the following table, showing the comparative increase in production of corn and in the population of the United States.

POPULATION, AND PRODUCTION OF CORN IN THE UNITED STATES, 1850 to 1900

Year.	Population.	Total Production Corn in Bushels, United States.	Bushels per Capita
1850	23,191,876	592,071,104	25·5
1860	31,443,321	838,792,742	26·6
1870	38,558,471	760,944,549	19·7
1880	50,155,783	1,754,591,676	34·9
1890	62,622,190	2,122,327,547	33·8
1900	75,997,873	2,666,440,279	35·0

The corn crop is the most important crop of the United States. Its value was 58·4 per cent of the value of all cereal crops grown in the United States over a period extending from 1866 to 1907. The highest average yield was obtained over the entire corn acreage in the United States in 1872, with an average of 30·8 bus. per acre, and the lowest average yield for the United States was in 1901, with an average of 16·1 bus. per acre. The greatest single limiting factor in yield is the amount of rainfall, and in 1901 the amount of precipitation was far below normal all over the corn belt. A careful survey of the yields of corn compared to the precipitation over a

series of fifty years shows that the yields varied up or down, comparing closely with the deviation of the precipitation from the normal. A small precipitation during the growing period is almost always accompanied by a small yield. It is estimated that about 300 lb. of water is transpired by the corn plants for every pound of dry matter; and when the enormous production of dry matter per acre in a crop of corn is taken into consideration, the reason for a large precipitation being necessary to a large yield is apparent. While corn is a semi-tropical plant and requires for its maximum growth a large amount of sunshine, and relatively high temperature, no direct relationship between yield and average temperatures can be traced. Late spring and early autumn frosts seriously affect and decrease the yield. The normal growing season is about 120 days under favourable conditions, and the highest yields are secured at an altitude of from 0 to 1000 ft. above sea level. The adaptation of varieties to shorter seasons, higher altitudes, regions of less rainfall, and other unfavourable conditions, however, the varieties being adapted by seed selection and breeding to heretofore unproductive and totally unfavourable conditions, has made great progress during the past few years. As a result of this work of acclimatization, corn is now being grown in many regions successfully where a few years ago it was considered that corn culture was impossible, or at any rate impracticable.


Maize (Indian Corn), showing Stem with Leaves and Inflorescence

Description of Plant.—The corn plant is monocotyledonous. It is monœcious, the staminate and pistillate flowers both being borne on the same plant but at different places. The staminate flowers are arranged in the form of a panicle or terminal inflorescence, called the tassel, while the pistillate flowers are borne on a hardened spike or cob coming from a node on the main stem. In the tassel there are two single flowers in each spikelet, and each flower has three stamens borne upon slender thread-like filaments, which lengthen during the development of the flower, and push out the pollen-bearing anthers. The anthers are two-celled, and on their maturity split just above and along one side, allowing the pollen grains to be shaken out by the wind, by which means they are wafted long distances. It has been estimated that each anther develops about 2500 pollen grains, and as a single tassel bears about 10,000 anthers, the corn plant produces about 25,000,000 pollen grains. The pistillate flowers are protected by husks or modified leaves, which open to permit the projection of the stigmatic portion of the silk. This stigma, in a receptive condition, is moist with a sticky substance, and covered with fine hairs. Pollen grains falling on the receptive stigma are caught by the fine hairs, and under the influence of the moisture of the stigma, and the heat of the air at this season, germinate. The germinating pollen grain sends a pollen tube through the hollow style to the tip of the ovule, when the nucleus of the pollen grain unites with the egg cell within the ovule, and fertilization takes place. The fertilized egg cell begins growth, and together with the surrounding ovary develops into the kernel of corn. There are from 500 to 1000 ovaries borne on the spike, with a style or silk for each ovary.

Corn is naturally cross-fertilized. As a rule the tassel develops and ripens pollen from one to two weeks before the silks appear. So that the silks of a plant are pollinated by the pollen of some near-by plant, the pollen of which has matured and been carried by the wind to the receptive silks. Self-fertilization in corn has usually been followed by loss of vitality, reduced productiveness, and has generally given inferior results to cross-fertilized seed. The great mass of pollen produced by a single plant, in comparison to the number of ovules to be fertilized, seems to be a provision of nature providing for safe cross-pollination.

The corn plant is fibrous-rooted, and bears two sets of roots, one set developing from the base of the stem, called primary roots, and the other set springing from the lower nodes of the stalk, called secondary roots or brace roots. The stem is made up of a series of sections, called internodes, varying in length from a few inches at the base to 12 in. or more at the top. The internodes are separated by nodes, which are short, thick joints. The cylindrical shape of the stem, the woody wall surrounding the pith, and the arrangement of the nodes and internodes all tend to support the plant under all

conditions. The leaves, varying from 12 to 18 on the individual stalk, arise from the nodes, and for some distance enclose the stalk in the form of a sheath. The leaves are arranged alternately, and are provided with a fringe which clasps the stem closely, so that water is collected from the surfaces of the leaves at this point, and allowed to drip to the ground at the base of the stalk. The plant reaches a height of from a few inches to 20 ft., depending on the influencing conditions, such as climate, soil, variety, and method of culture. However, the normal corn plant varies from 5 to 12 ft. in height. As a rule the plants are of small size in northern latitudes, both as regards height and circumference of stalk, and amount of leaf surface, and increase in size and amount of foliage as the plants are carried farther south. The plants are usually dwarfed in high altitudes, and increase in size in lower altitudes.

CULTURE.—*Preparation of the Seedbed.*—The conditions for germination of seed corn are vitality, proper temperature, oxygen, and moisture. The preparation of the seedbed is for the purpose of providing the proper conditions of temperature, aerating the soil, and regulating the supply of moisture for the seed when planted. For this purpose the land is usually ploughed deeply, the depth depending on soil conditions, but in the corn belt generally to a depth of from 6 to 8 in. This deep breaking opens up the soil to the influences of the air and sunshine, breaks the capillarity of the soil, so that the ploughed bed becomes more effective in retaining the soil moisture, and destroys weeds and foreign plant growth on the land. After ploughing, the seedbed is thoroughly stirred by the use of disks and harrows, to reduce the soil to a fine tilth or mechanical condition for the germination of the seed and the growth of the plants. In the rich prairie soils of the Mississippi valley very little if any commercial fertilizers are used. In other regions, where the soil has become unproductive through cropping or from other cause, potash, phosphoric acid, nitrogen, and lime are frequently applied, the amounts used depending on the character of the soil. It has been found that a rotation of corn with oats and clover or some legume gives better results than where corn is grown successively on the same land. The usual practice is to grow two or three crops of corn, then one crop of oats in which clover is seeded, and allow the clover to grow one year, harvesting it once for hay and once for seed, then replanting the land to corn. When the soil has become acid, an application of 500 to 1000 lb. of lime per acre is used. If the soil is deficient in phosphoric acid, an application of about 500 lb. to 1000 lb. of acid phosphate per acre is used; and if the land is deficient in potash, from 250 to 300 lb. of sulphate of potash is applied. Barnyard manure at the rate of from 8 to 12 tons per acre is applied to supply a deficiency in nitrogen and to improve the tilth of the soil. In fact, it has been the practical experience of corn growers that barnyard manure, used at the rate mentioned above, with lime, is the most satisfactory and practical form of fertilizer for use on corn lands. The barnyard manure should be spread over the land before it is ploughed, while the application of lime should be made after ploughing. The object of the preparation of the seedbed should be to reduce the soil to a fine mellow condition, absolutely free from weeds, providing for a quick germination of the seed and rapid growth of the young plants.

Planting.—Different methods of planting corn are practised in different regions, depending on custom, the lay of the land, acreage planted, and many other factors. The best methods for use on a commercial scale seem to be the planting of the seed in hills about 3 ft. 6 in. apart both ways, or in squares of this size. Three kernels planted in a hill have given maximum results, but the number of kernels planted in each hill must depend on the soil, climate, and other factors. If the corn is planted in this manner and properly checked, it can be cultivated in two or more ways with modern cultivators, which cultivate both sides of a row at the same time. This method does away with expensive hand cultivation with hoes or other implements. Shallow cultivation with small shovels has given universally better results than deep cultivation in fields planted in this manner. The practice of listing corn is practised locally in some regions. In this method a combined plough and planter is employed, the kernels of corn being dropped in the furrows made by the plough. The land receives no other cultivation than that given by the plough. This method is not, however, a general success. The drilling of the seed, one kernel at a time in the row, usually planting a kernel every 12 or 14 in., is practised to a limited extent, and in some cases is reported to give better results than the hill method.

Cultivation.—The object of cultivating the corn land is to aerate the soil, conserve soil moisture, and destroy weeds. On account of the development of the fine fibrous roots in the soil near the surface, deep stirring of the soil during the growth of the plant is likely to injure these roots. Any injury to the roots during cultivation is detrimental to the growth of the plant and consequently to the yield of the crop. For this reason, shallow cultivation, merely stirring the surface two or three inches of soil frequently, at least once a week, or oftener during dry seasons, has become the universal practice amongst all successful corn growers. Many kinds of implements have been invented to more economically cultivate the cornfields, but perhaps the most universally used is the single-row cultivator, with four small shovels on each side, attached to handles so that the shovels may be guided about the plants so as to stir the soil near the plants without injuring them. The character of the soil determines the kind of cultivator best adapted for securing the optimum results. The nature of the season will determine largely the requisite number of times for cultivation in order to secure the best results, it being desirable to cultivate more frequently during dry seasons to conserve soil moisture.

HARVESTING.—About 25 per cent of the corn crop of the United States is husked out in the

field and shipped away from the farm where grown. A portion of this corn is exported, but the majority is used in the manufacture of feeding products for live stock, the manufacture of glucose, alcohol, various products for human food, *e.g.* corn starch, hominy, and various grades of corn meal. The bulk of the crop, however, is fed to live stock on the farms where raised. It is usually husked in the field, stored in cribs or bins, and fed to stock on the ear, or ground into a fine meal. The stalks standing in the field are pastured, the animals eating the husks, a portion of the leaves, and stalks. A limited amount of the corn crop is harvested by cutting the stalks when the ear is in the milk stage of maturity, and storing the crop in silos. This practice is followed largely in dairy sections, where silage has been found to be particularly valuable for milk production. Another method of harvesting the crop is to cut the stalks just after the ears have passed the milk stage, and stack them in small stooks in the field, where the stalks are allowed to dry out, after which they are run through a shredder, the ears husked out, and the stover (*i.e.* the corn stalks after the removal of the ears) torn into small bits, which are more easily masticated by the animals to which the corn is fed.

The invention of the corn harvester, whereby the corn plants may be cut and tied in convenient-sized bundles by machinery, has greatly accelerated the practice of cutting the plants, and either storing the plants in silos or shredding them for feeding purposes. Corn pickers for husking the corn by machinery have begun to come into practical use. However, the chief means of harvesting the crop is husking by hand, and one man with wagon and team can average 70 bus. per day in corn yielding an average of about 50 bus. per acre. The safe keeping of the husked corn depends on its rapid drying during storage. As a rule corn shrinks about 10 to 15 per cent in weight during the first year of storage, and but 1, or a fraction of 1, per cent the second and following years.

Feeding Value.—The feeding value of corn depends on its percentage composition of digestible nutrients and the proportion of the components, its palatability and ease of mastication, and cost of production and preparation. The composition of corn in its different forms is as follows:—

	Water	Ash.	Protein.	Crude Fibre.	Nitrogen-free Extract.	Fat.
Dent varieties	10·56	1·53	10·25	2·24	70·40	5·02
Corn meal	14·98	1·42	9·17	1·90	68·76	3·77
Corn cob	10·70	1·40	2·40	30·10	54·90	0·50
Corn and cob meal	15·08	1·46	8·45	6·62	64·86	3·53
Corn fodder	42·20	2·70	4·50	14·30	34·70	1·60

The protein is 76 per cent digestible, carbohydrates or nitrogen-free extract 94·7 per cent digestible, and the fats 84·8 per cent digestible. In view of the fact that such a large percentage of the corn is utilized by animals, it makes corn one of the most economical foods for live stock. As a matter of fact, cost of corn to produce pork, beef, or milk is lower than in the case of any of the other cereals. The popularity of corn as an article of human food is rapidly increasing, so that its use in this direction is becoming an important factor in the consumption of the crop.

The cost of production of corn in the United States has been carefully investigated, and the results show that under average conditions the actual cost in the production of the crop is about 12·9 cents per bushel. If the interest on the investment, depreciation in machinery, and interest in value of land be included, it brings the cost of production up to about 21·5 cents per bushel.

Breeding.—The systematic selection of different types of dent corn, adapted to definite conditions of soil and climate, and for increased productiveness or yielding capacity, is of comparatively recent origin. The Illinois experiment station was among the first sources of information as to the productiveness of different types of corn, and the higher yielding character of those types which had been carefully selected for this purpose by practical corn breeders. It was pointed out that ears of the same variety and type, grown under the same conditions, differed in their productive efficiency or transmitting power, hence in their comparative value for seed. It was also discovered that the ears varied in their composition, as to percentage of oil, protein, starch, &c., and that these characters were transmitted comparatively true to seed. Since this discovery it has been found possible, on a practical basis, to test the productiveness of individual ears, and determine their relative value, so that it is possible to isolate the high-yielding types and propagate them true to seed. It has also been found to be practical to isolate strains developing a high oil, protein, or starch content, and in this way to originate varieties specially adapted for oil, glucose, alcohol, or other manufactured products, or for animal feeding purposes. There are at present three varieties of dent corn which have been the source of most of the improved varieties now propagated in the United States. These are: (1) the Leaming, a yellow dent variety originated by J. S. Leaming, of Wilmington, Brown Co., Ohio, about 1825; (2) the Boone Co. White, a white dent variety originated by James Riley, of Thorntown, Indiana, about 1870; and (3) the Reid's Yellow Dent, a yellow dent variety originated by James L. Reid, of Delavan, Illinois, about 1846. The principal flint variety grown in northern latitudes is called the Canada Eight-rowed variety, a yellow flint variety bearing, as a rule, eight rows of kernels to the

ear, the origin of which probably dates back to the settlement of the eastern colonies of the United States about 1625 or 1630.

In general, it may be said that seed corn should be grown under the same soil and climatic conditions as where it is to be planted. In other words, so far as possible every corn grower should breed his own corn. The use of imported seed frequently leads to a lack of stand, immature crops, and a financial loss to the grower. On the other hand, progressive corn growers test all important varieties of corn to determine the best existing variety for their conditions. After a desirable variety is determined, it then becomes the business of the grower to discover the most productive and valuable type, isolate by planting the ears of this type in a seed patch separate from other corn crops, and continue from year to year the propagation of the most productive individual strains, and to cross-breed *these strains* at frequent intervals. To determine the relative productiveness and value of the individual ears of a given type, the ears in the seed patch can be planted in separate rows, the yield of these rows determined, and seed saved and propagated only from the highest yielding rows. However, the writer uses this ear-to-row method simply to determine the characters of the highest yielding and most valuable types and individual ears, thus enabling him to select the desirable seed ears wherever they may occur in the seed field.

As a rule the heaviest mature ears in an acclimated variety are the most productive, and of the most valuable composition for feeding purposes. In practice the selection of these best ears year after year, keeping the seed free from crossing with other or inferior types and varieties, has resulted in the production of all of the improved varieties known to the writer. [A. D. S.]

Maize.—Parasitic Fungi.—The following are some of the most destructive parasites on maize in Europe and America: Rust (*Puccinia maydis*), of which the uredospores and teleutospores alone are known; Smut (*Ustilago maydis*), very destructive, producing swollen deformed cobs, and swellings on other parts of the plant filled with black smut spores; Bunt, or Stinking Smut (*Tilletia*), on Australian maize; Leaf Stripe, similar to that on barley, caused by *Helminthosporum turcicum*. The life-histories of these fungi are the same as corresponding ones on other cereals; prevention is effected by similar treatment. See arts. BARLEY—PARASITIC FUNGI, and WHEAT—PARASITIC FUNGI. [W. G. S.]

Maize as a Fodder Crop in Britain.—The main object of the cultivation of maize in the British Isles is the production of a green fodder crop for use in the latter end of the summer when the pastures are 'giving out'; it is also grown for ensilage (see ENSILAGE), and for sheep-keep, folding on the ground where it is grown. The seed must not be sown until the ground is warm enough for rapid germination and all danger of frost is past. The soil must be in good condition, as the plant with its extensive production of stem and leaf makes considerable demands on the soil, so that the manuring may be similar to that adopted with other plants grown for their leaves—cabbages, &c. The land intended for maize should be winter-ploughed, manured with 10 to 20 loads farmyard manure ploughed in, followed by sufficient working of the land to get a fine seed-bed. The seed, at the rate of 2 bus. per acre, is either drilled or dibbled at 24 in. between the rows and 4 to 6 in. between the plants; and it is important to immediately 'string' the field (to keep off rooks, which have a particular liking for the grain) on short sticks about 2 ft. high, it being sometimes necessary also to 'tent' the field, the hours just after daybreak being those most often chosen by the birds for their attack. After drilling, the ground is harrowed and rolled; after the plants are well through, one or two hoeings may be necessary to clean the plants and to make a mulch. It is difficult in this country to obtain maize seed of any special variety, as the corn cannot be properly ripened for seed purposes in our climate; it is therefore necessary to fall back upon the commercial feeding maize, and trials should be made to determine the relative cropping capacities of both the flat and round corn. The expense of importing any special variety from the United States or Canada is prohibitive as a rule. A warm summer suits the development of the plant best, and a growth of 9 to 10 ft. is not uncommon in a favourable season, when cobs of a fair degree of maturity are found. Cutting for green fodder can be commenced early in September if desired, and continued until the season of frosts sets in. For ensilage purposes it is desirable to obtain the plant in the most mature state possible. All classes of stock do well on the green fodder, and the feeding of it to dairy stock gives a welcome stimulus to milk production.

Maize may also be grown in favoured spots for sale as a green vegetable. The method of cultivation is as has been stated, but the plants should be wider apart in the rows, and the risk of early sowing must be taken. Considerable success has been achieved in Essex in this production, the cobs being marketed at 1*s.* to 2*s.* per dozen. If the production of cobs in the kitchen garden be desired, it is necessary to raise the plants in the houses, and to plant out when danger from late frosts is not feared. [M. J. R. D.]

Maize Meal.—This largely used feeding material is obtained from maize, or indian corn, (*Zea Mays*), the 'corn' of the United States. Maize is grown principally in America, the south of Europe, and many parts of Asia and Africa, as well as in Australia, New Zealand, and the West Indies. In India it is grown mainly as a fodder crop. America is the largest producer of maize, but the home consumption of it is enormous, and not so much is available for export. The Argentine crop, on the other hand, is mainly exported. Maize from South Africa contains less moisture than any other, and fetches a good price in consequence. South Russia produces a large crop, which goes chiefly to Western Europe. Roumania, Morocca, Java, and Manchuria also produce maize in small quan-

tity. The principal varieties of maize coming to this country are the 'round' maize and the 'flat' or 'horse-tooth' maize. The grain is sometimes given whole, and, as such, figures in mixed foods like 'lamb food', or as food for poultry and game; but it is principally given to cattle in the ground state as 'maize meal'. The following analysis represents the general composition of maize meal:—

Moisture	12·47
Oil	4·53
[1] Albuminous compounds	8·87
Starch and soluble carbohydrates, &c.	71·49
Woody fibre	1·10
Mineral matter (ash)	1·54
	100·00
Containing nitrogen	1·42

Maize meal, owing to its ground condition, is rather more moist than the original grain, which generally contains only about 10 per cent of water. It is chiefly of value because of its starchy ingredients, and is, when its price is not too high, a favourite material for mixing with concentrated nitrogenous foods such as decorticated cotton cake. The oil is moderately high in amount, but is not specially good as a fattening constituent, though the extracted oil is sometimes made use of as an addition to compound feeding cakes, in order to increase the oil percentage. Maize meal is essentially a starchy and not a nitrogenous food, and on that account was selected in the Woburn Rotation Experiments by way of contrast to the highly nitrogenous food decorticated cotton cake, for the purpose of testing the value, in practice, of Lawes and Gilbert's Tables of the compensation manurial value of purchased foods. Maize meal has only about 1·4 per cent of nitrogen, while decorticated cotton cake has about 6·9 per cent. In well-ripened maize, 94 per cent of the nitrogen is in the albuminoid form. It contains but little indigestible fibre, and so is an easily digested food. Of the nitrogenous matters, 76 per cent is reckoned to be digestible, and 93 per cent of the soluble carbohydrates, with 86 per cent of the fat.

It is but little adulterated, and is generally found to be in good sound condition, also keeping very well when stored.

It is a very favourite food for milking cows, and imparts no strong flavour to butter. For fattening bullocks maize meal is in much request, and forms a very good material for supplying the starchy constituents in a mixed diet of which cake forms a considerable part. In this respect it is considered as being much superior, as a fattening medium, to home-grown starchy food such as barley meal, or to rice meal and similar starchy purchased foods. Its price is too high to allow of its use for young or store stock, for which, moreover, it is not so suitable as for dairy cattle and fattening stock. For horses, more especially those employed in towns in tramway and omnibus work, crushed maize is very largely used, while the ground meal is often given to sheep when feeding off roots on the land. In the United States maize meal is much employed for fattening pigs, but its tendency is to produce a 'soft' fat, and it is but seldom so used in this country.

Maize is considered a 'heating' food, and if fed too freely to horses engaged in town work it gives rise to diarrhœa, and the maize passes out largely undigested. Next perhaps to cotton seed, maize meal is the most common ingredient of mixed feeding or 'compound' cakes, and there are few kinds of these on the market which do not contain maize in good amount. The whole maize arrives in this country very clean and free from admixture, so that it requires no screening or preliminary treatment. As with other grains, it is much the best to buy the maize itself, and to crush it into meal on the farm.

Many different preparations of maize are made for feeding purposes; the most of these have as their base the cooking and 'flaking' of the maize, in order to render it more readily digestible. Though these are in many cases very nice preparations and very 'tasty', it is open to question whether maize—which, as shown before, is a very digestible food—calls for the 'cooking' to which it is subjected in these preparations. No doubt, when given whole, loss may be incurred by the grain passing through the animal unaltered, but this is remedied by crushing the grain, or, better still, by grinding it into meal.

To fattening bullocks or milking cows, maize meal may be given up to 6 lb. and 8 lb. a head daily, while for sheep ½ lb. to 1 lb. per head daily is an ordinary allowance. Considered in the light of its manurial value, maize meal, being essentially a starchy material, ranks low. It has—as the analysis given of it shows—but little mineral matter, and this comprises about ·60 per cent of phosphoric acid and ·37 per cent of potash. It is very poor in lime, and does not contain enough for animal requirements. According to Voelcker and Hall's Tables, the compensation value per ton consumed is as follows:—

Last year.	Second year.	Third year.	Fourth year.
13*s.*	6*s.* 6*d.*	3*s.* 3*d.*	1*s.* 7*d.*

—these figures being less than one-fourth of the corresponding ones for decorticated cotton cake.

Maize-germ Meal.—In addition to the ordinary ground maize or maize meal just described, there is another meal prepared from maize by removing—as is done in the 'roller-mill' process—the 'germ' of the grain, and grinding that up separately. The germ is marked by its sweetness and by its richness in oil. The 'germ meal' accordingly forms a very favourite feeding material, particularly for milking cows. The following analysis represents its general composition:—

Moisture	10·06
Oil	10·78
[1] Albuminous compounds	12·75
Sugar, starch, &c.	58·60
Woody fibre	4·28
Mineral matter	3·53
	100·00
[1] Containing nitrogen	2·04

Care must be taken, when purchasing, to see that

the genuine 'maize-germ' meal is supplied, as not unfrequently the product is mixed with ordinary maize meal, and may be but little better than the latter. [J. A. V.]

Malay Fowl. — Although this breed has not much value for practical poultry-keepers—being chiefly kept in this country as a fancy fowl—yet it has had considerable influence upon some other breeds. The evidences are that it originated in south-eastern Asia, whence it was brought to Europe direct. It is a fact that in south-eastern Asia cock-fighting has been a pursuit very widely adopted, and although probably the Malay itself was not used for this purpose, it has been evolved from the breeds which were largely employed in that way. The evidence obtainable would show that the birds used for fighting were shorter in the leg than those which we are accustomed to see here, and that they were very keen indeed in the cockpit. The Malay has a large body, is very heavy in bone, —in fact males will frequently weigh 12 lb. and upwards. It is very thick in the head and neck, and has peculiar brows, often overhanging the eyes, and these give it a very ferocious appearance. The comb is shaped like a half walnut. The muscular development is enormous, the shoulders being broad and very strong, and the muscles both of the breast and of the legs are very hard and firm. The flesh is yellow and somewhat tough, but wonderfully developed. As a layer it is poor, but the eggs are very rich and have thick shells. So far as coloration is concerned there are four varieties, the most common of which is the Red, with darker reflections on the wings, neck, and tail. Another variety, which is rather more pleasing in appearance, is the Black Red, in which the head, hackles, back, and upper parts of the wings are a rich-red, and the breast, under parts, wing bar, and tail deep-black. There are also White and Black self-coloured birds, but not many of these are seen. All have yellow legs and flesh. The chief value of the Malay is for crossing, and it is generally admitted that the Indian or Cornish Game owes some of its special qualities to this breed. For farm purposes Malay fowls would be useless, as they are very pugnacious, and not many can be kept together. Hence practically the only value of the Malay, apart from its exhibition qualities, is in the direction of crossing. [E. B.]

Malformation. — By malformation we mean a peculiarity of animals that are congenitally defective, or subsequently deformed by accident or disease: not the monstrosity, such as the eight-legged lamb to be seen in a glass case at the village inn. As practical agriculturists and stock-raisers, we shall find it desirable in most cases to sacrifice the life at once of the malformed, but some discrimination may be exercised, as the 'ugly duckling' may eventually prove worth rearing for his own sake; but no animal or bird with a malformation should be allowed to breed, because defects of the kind have a tendency to recur in the next or subsequent generations. Some very disproportionate colts, calves, and pigs, which could scarcely escape classification among the malformed, subsequently 'grow out' as it is called, the abnormalities disappearing to some extent by the greater development of more desirable features. High-domed heads, and excessively long hind legs, pasterns bending so as to touch the ground with the fetlock, bowed knees, and withers much lower than the line of the back, are malformations from which many youngsters recover if well cared for; and we should not be too rash in destroying animals somewhat malformed, without submitting them to the judgment of men of experience in such matters. [H. L.]

Malines Fowl.—In Belgium, where poultry-breeding is carried out upon very practical lines, the chief bird for table purposes is the Malines, of which there are three varieties: (1) *the cuckoo*, which is the oldest; (2) *the white*; and (3) what is called *the turkey-headed black*, the last-named of which is of more recent introduction and has not yet gained any great amount of popularity. The first two named are chiefly employed for producing birds for the Brussels and other markets, and the specimens there seen are large in size, good in flesh development, although they do not present so plump an appearance as many of the best table fowls met with in England and France. It is generally supposed that the Malines fowl is due to a cross between the Antwerp Brahma and the common fowl of the country, although probably other breeds have also been employed, one of which would appear to be the Langshan. The Malines fowl follows very closely upon the Asiatic type, and has the upright formation of body met with in the Brahma and Cochin. It is large in size, adults weighing as much as 11 to 12 lb., sometimes more, whilst the females are from 8 to 10 lb. It is long in body and has a deep keel, the neck is short, surmounted with a strong head, and in this respect shows a good deal of the Langshan character. The comb is single, standing upright in both sexes, the wattles are long, and the legs and shanks are of fair length also. Whilst it cannot be said that the bone is heavy, still the legs are strong, and in many cases have a slight covering of feathers on the outer side. The legs and feet are pinkish-white in colour, with which is associated creamy-white flesh. Although this breed is largely employed for table chickens, it might fairly be placed in the general-purpose class, as the birds are good layers and also excellent sitters and mothers. In respect to size of egg, the Asiatic influence is again very evident, as they are somewhat small and usually very round. They are nicely tinted in colour of shell. It must be acknowledged, however, that the flesh is to a greater extent upon the legs than is regarded as desirable in the finest races. Its chief quality is owing to its quiet temperament, which enables the birds to be fatted easily; in fact a restless active breed would not submit itself to that process. For what may be termed a second-class trade there is no doubt that the Malines fowl is an excellent one. The Cuckoo variety is most popular, but the Whites are increasing greatly in favour. [E. B.]

Mallard.—The Mallard (*Anas Boscas*), or

Common Wild Duck, is resident in suitable places in Great Britain throughout the year, but its numbers are largely increased during the cold months by the enormous flocks which arrive from the Continent. In the fen countries it used to be caught in great quantities in decoys; and even now, there are a certain number of decoys still worked with profit. Incubation commences at the middle or end of March; the nest is made of grass, lined with down, and is usually situated near the edge of lakes or rivers, though occasionally at a considerable distance from water. The Mallard is a night feeder, and its diet consists of worms, slugs, insects, grain, or seeds; it will, in fact, eat almost anything. The two sexes differ markedly in plumage. The drake has the head and neck glossy-green, with a narrow white ring round the neck; the back of the neck and breast dark-chestnut; the four central upper tail-coverts black and curled upwards; the under parts greyish-white; the legs, toes, and webs orange-red. Between May and October his plumage undergoes an 'eclipse'. The bright colours are lost, and a brown plumage assumed, resembling that of the female. The quills are cast at the same period, so that the bird is then incapable of flying. The Mallard is the origin of many of our domestic breeds of duck.

[H. S. R. E.]

Mallein Test.—The mallein test is a valuable means of diagnosing latent glanders when there are no definite clinical signs but the disease is suspected, as a result of association with horses in which it has declared itself. It is a much more reliable test than that of tuberculin for tuberculosis. It was discovered by two Russian veterinarians, Kalning and Helman. The *Bacillus mallei* is cultivated in a suitable medium; the resulting culture heated to a point at which the organisms are killed; the fluid is filtered through porcelain, glycerine and carbolic acid is added, and this constitutes the yellowish-brown fluid called mallein. By hypodermic injection a typical swelling is produced, on an average, in about twelve hours, and this increases until about the twenty-fourth, when it begins to recede. The temperature rises four or five degrees, and taken in conjunction with the character of the swelling, enables the operator to pronounce definitely in most cases. Doubtful reactors, in which neither temperature is high nor swelling considerable, are marked for subsequent testing. See GLANDERS. [H. L.]

Mallenders.—This name is given to an eczematous eruption behind the knee, and is of frequent occurrence among horses of the heavier breeds, but by no means confined to them. Sallenders are precisely the same in character, but situated in the flexure of the hock. A first attack may be radically cured by an aloetic ball, fomentation, and the application of zinc ointment containing 20 drops of carbolic acid to each ounce of the B.P. preparation. Chronic cases need habitual care to prevent ulceration and the encroachment of scaly matter above and below the bends of the knees and hocks respectively. Cleansing with soft soap, mopping with a soft cloth, and the application of an ointment as follows, two or three times weekly, has been found to keep the parts healthy, if not always healing entirely: 20 gr. of finely triturated red oxide of mercury, 60 gr. of exsiccated alum, and 6 dr. of lanoline ointment. Diuretics should be given to subjects of this disease. An ounce or two of sulphate of magnesium, ½ oz. or more of nitre, and 2 oz. of sulphur, in a mash, once or twice a week, is a suitable dose. [H. L.]

Mallophaga (Bird Lice).—These insects are a group of Neuroptera which are parasitic on poultry and other birds, causing severe irritation in some cases, and thus weakening the health of poultry and making them more susceptible to other diseases, such as diphtheritic roup, tuberculosis, &c. They also gnaw and destroy the plumage of show birds, and cause such intense annoyance to setting hens that they forsake their nests. Chicks also are infested with them on their heads and necks (see GONIODES EYNSFORDII). The Mallophaga have a biting mouth, and live on the epidermal products, skin, feathers, &c. They are all wingless or apterous insects which undergo very little metamorphosis, the young being very similar to the adults, but smaller and very pale in colour. They lay their eggs on the feathers of birds as a rule (see GONIODES), but some in the nests (see MENOPON). The ova are elongated-oval, and have a reticulate shell, and are held to the feathers by delicate threads at their base. The insects are mostly entirely parasitic on the birds (see GONIODES and GONIOCOTES), but may be partially parasitic, as seen in the Menopons or crawling lice.

The *treatment* for lice in poultry is frequent cleaning of the nesting boxes, &c., and the provision of dusting boxes in dry places for the birds. Ash and road dust and lime make a good mixture, or road dust, lime, and sulphur (only a small quantity of the latter). Nesting hens may be kept free by placing pyrethrum powder in the nesting boxes, and by seeing that they are clean before allowing them to set in *clean* nesting boxes. Different species of birds have different species of lice upon them.

[F. V. T.]

Mallow, hardy annual, biennial, or perennial herbs (nat. ord. Malvaceæ), with purplish-rose or white satiny-petalled flowers, natives of the Old World. Most of the species are of coarse and weedy habit, and of little worth. *Malva moschata* (Musk Mallow), a native plant, and its white variety are those most grown. They attain 2 ft. in height, and will thrive in any soil. *M. crispa*, an annual 3 to 6 ft. high, white flowers with purple tips, thought to be a native of China, is also a useful plant. The perennials are increased by cuttings or seeds, and the annuals by seeds. [W. W.]

Malt and Malt Products.—Malt, or partly germinated grain, is one of the most important raw materials of the brewing and distilling industries. In these industries alcohol is produced from the starch contained in such materials as grain or potatoes, the starch first being converted into a sugar which can then be fermented to alcohol by yeast. This change of starch to malt-sugar is brought about under

suitable conditions of temperature and moisture by means of a ferment or enzyme, *diastase*, which is present in grain, and greatly increases in amount and activity during the earlier stages of germination. The primary object of 'malting' the grain is thus to obtain a liberal supply of this sugar-producing ferment in highly active condition. Any starchy grain will yield a malt on germination, but barley excels all others for this purpose, and is indeed the only grain used to an appreciable extent by the brewer in this country.

In the manufacture of malt, the barley—after being graded, cleaned, and, if necessary, dried ('sweated') and stored for some time to 'mellow'—is steeped in water at 50° to 55° F. until it contains nearly one-half its weight of moisture, two or three days' steeping usually being required. The moist, swollen grain is then spread out in a layer ('couch') 12 to 16 in. deep on the floors of large well-ventilated rooms, where it soon commences to germinate. The growing corns take in large amounts of oxygen from the air and give out correspondingly large amounts of carbonic acid gas, this oxidation ('respiration') being accompanied by the development of much heat. It is necessary, therefore, to stir the grain from time to time for the double purpose of securing adequate aeration and of maintaining the temperature of the grain at a suitably low level (50° to 65° F., best 55° to 60° F.). A sprinkling of 1 to 4 gal. of water per quarter is given when the grain has been out of the cistern about five days. The progress of the germination is gauged partly by the appearance of the endosperms of the grain, and partly by the extent to which the rootlets and young shoots have developed. The usual duration of the 'flooring' is about ten to fourteen days, by the end of which period the rootlets have generally grown to about one and a half times the length of the corns.

The sprouted grain is now removed from the floors, and may be used directly in the distillery as 'green malt', but for storage and brewery purposes must be dried. The drying is effected in special kilns at carefully regulated temperatures, rising gradually from about 100° F. to not more than 165° or 175° F. As the grain dries it acquires the characteristic aroma and sweet taste of dry malt. The activity of the diastase steadily falls, however, as the temperature rises, so that the regulation of the temperature is a matter of great practical importance.

If the malt is required for beer, the heating must be prolonged still further, the temperature being again increased after the moisture-content of the malt has been reduced below about 5 per cent. The maximum temperature attained in this 'curing' of the malt varies according to the colour and flavour required, these qualities becoming more pronounced the higher the curing temperature, owing to changes such as the conversion of some of the malt sugar into brown caramel-like products.

In most cases the kiln is so constructed that the fumes from the fire pass through the malt. This is said to improve the quality of the malt, but it conveys the risk of arsenic from the coal being transferred to the surface of the malt and ultimately to the beer made from it. The proportion of this poison in the finished malt is, however, rarely so high as to be actually dangerous, and can be reduced to a negligible amount by careful withdrawal of the dust thus formed.

From the kiln the malt is thrown upon wire screens with the object of detaching the brittle dried rootlets and shoots, owing to the unfavourable influence which they would exert on the flavour and keeping quality of the liquor. The material that passes the screens is largely used for feeding purposes on the farm under the name of malt culms or coombs (see below), whilst the malt proper, after exhaustion with water for the purposes of the brewer or distiller, returns to the farm as 'grains' (see BREWERS' GRAINS, DISTILLERS' GRAINS).

The yield of screened malt is usually about 78 per cent of the weight of air-dry barley malted, the accompanying 'culms' amounting to 3 or 4 per cent—these yields corresponding to a total loss of about 8 or 9 per cent of the dry matter of the barley. Fully two-thirds of this loss is due to the respiration during germination, the materials thus removed being moreover those which are most easily rendered soluble. Obviously, therefore, the malting of grain must be accompanied by very considerable loss of digestible matter. The remaining losses arise during the steeping of the grain (2 per cent) and the handling of the dry malt on the kiln.

With regard to the changes in the chemical composition of the barley on its conversion into malt, these occur almost entirely during the period of germination, their general trend being towards the production of soluble matters, through the agency of enzymes, from the insoluble reserve materials of the grain. Thus the insoluble albuminoids are steadily converted into soluble albuminoids and amides, the starch to malt sugar, &c., whilst at the same time the vigorous respiration of the growing grain involves the oxidation of appreciable quantities of the starch and oil present to gaseous carbonic acid. Further also a certain amount of bacterial fermentation takes place with production of small quantities (up to 1 per cent in all) of acetic, propionic, lactic, and other acids. In other words, the ingredients of the endosperm undergo changes closely analogous to those which they would undergo during digestion in the animal, the digested materials in this case going to nourish the growing embryo.

It must be remembered, however, that these changes can only proceed to a limited extent, since the germination is interrupted as soon as the starch has been placed in the most favourable condition for the brewer by the action of the enzyme *cytase*, which dissolves away the walls of the cells in which the starch granules are enclosed, thereby exposing the latter to the action of the diastase. In other words, it is not so much the object of the maltster to produce sugar in the grain as to enrich it in diastase, and so modify the starch that sugar may be rapidly produced when the brewer requires it.

Apart therefore from the slight lowering in

the proportions of soluble carbohydrates (notably starch) and true albuminoids, and the corresponding increase in the proportions of crude fibre and 'amides', the process of malting causes little difference in the percentage composition of the grain, as may be seen from the accompanying data, which represent roughly the average composition of the two materials:—

	Moisture.	Percentage Composition of Dry Matter.					
		Crude Albuminoids.	True Albuminoids.	Oil.	Soluble Carbohydrates, &c.	Crude Fibre.	Ash.
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
Barley ...	14	11	10½	2½	79	4½	3
Kilned malt	8[1]	10¼	8	2¾	75	9¾	2¼

[1] Brewers' malt usually contains less than 1 per cent of moisture when it leaves the kiln.

It will be observed that fully one-fifth of the crude albuminoids of the malt consists of non-albuminoid (amide) material. The soluble carbohydrates consist mainly of starch (60 to 65 per cent), but include also appreciable quantities (up to 20 per cent) of sugars, chiefly malt sugar, ordinary sugar (sucrose), and invert sugar.

The different ingredients are digested to practically the same extent in both barley and malt, although in the latter case digestion may perhaps be effected more rapidly. The palatability and possible condimental action of malt must not be overlooked, but the feeding trials of Lawes and Gilbert and others seem to indicate that any advantages arising from the malting of grain for feeding purposes are, for ordinary purposes, not sufficient to compensate for the trouble and unavoidable losses of digestible nutrients during the process.

It has been suggested by H. T. Brown that the richness of malt in the cellulose-dissolving enzyme, cytase, may perhaps lead to some increase in the digestion of rations rich in cellulosic material (hay, straw, &c.) when malt is added. The meagre evidence at present available affords little support, however, for this view.

'Irrespective of economy, malt is undoubtedly a very good food for stock; and common experience seems to show that a certain amount of it is beneficial when given in admixture, and in change, with other food to young or weakly animals, or in making up for exhibition or sale; that is, when the object is to produce a particular result irrespective of the economy required in ordinary practice' (Lawes and Gilbert).

Malt Culms or Coombs (or Malt Dust), as already indicated, consist of the screenings (dried rootlets and shoots) from the kilned malt. The shoots, being protected by the husk, are not as readily detached from the grain as the rootlets, so that the 'culms' consist almost entirely of the latter.

Along with the 12 to 13 lb. of clean culms usually obtained per quarter (336 lb.) of malt made, there is obtained about 3 or 4 lb. of the so-called 'kiln dust', *i.e.* culms which have been broken off in the kiln and have accumulated in the hot-air chamber along with a certain amount of coal dirt and ash blown up from the fire. Such malt dust, besides being rich in insoluble ash, is usually badly scorched, and hence dark-coloured. It is greatly inferior to the clean culms, and indeed more suitable for manurial than for feeding purposes.

The best malt culms are light-coloured, have a pleasant aromatic smell, contain very little dust, and are easily crumbled in the hand. When kept in a heap, especially if damp, they tend to ferment, and can then only be used with great caution. Strongly kilned culms are dark-coloured, ferment more readily, and require more care in use. Owing to their characteristic appearance malt culms cannot easily be adulterated, but barley screenings and dirt are occasionally met with.

The composition of malt culms varies greatly according to the nature of the barley, the duration of the germination, and the temperature of curing. The average composition and digestibility are much as follows:—

	Total.	Digestible.
	per cent.	per cent.
Moisture	10½	—
Crude albuminoids	23½	19
True albuminoids	[17]	[11½]
Oil	1½	1
Soluble carbohydrates, &c. ...	44	32
Crude fibre	13	7½
Ash	7½	—

According to Kellner, 100 lb. of culms of this composition should have a value for fattening or other productive purposes equivalent to 40 lb. of starch.

It should be noted that fully one-quarter of the total nitrogenous matter ('crude albuminoid') is non-albuminoid in character, the amide body, asparagine, being the chief of these non-albuminoid substances.

The 'soluble carbohydrates' consist largely of sugars (up to 20 per cent; mainly sucrose) and pentosans, along with small quantities of malic, citric, and other acids.

The ash is rich in phosphates (25 per cent P_2O_5) and potash (30 per cent K_2O), but very poor in lime (3 per cent CaO). The immediate value, at current unit prices, of the manure produced by the consumption of 1 ton of malt culms containing the above proportions of manurial ingredients will, after making the allowances recommended by Hall and Voelcker, amount to about 35*s*.

Despite the fact that so much of their nitro-

genous matter is in forms ('amides') having probably little direct feeding value, malt culms are commonly found to be a nourishing, highly palatable food, to some extent condimental in character, readily eaten by all classes of stock, and agreeing well when fed in moderate amounts.

They are highly valued for milk production, owing to the stimulating effect which they exercise when added to rations that are otherwise rather flavourless in character. They may safely be given in quantities up to 6 or 7 lb. per cow daily, preferably after scalding or softening with water.

They have also been used with considerable success in the rearing of young stock, although for such it is advisable to bear in mind their poverty in lime. Greater care is necessary in feeding them to breeding stock, especially to females in an advanced state of pregnancy.

Overheated, dark-coloured culms require special caution in their use, whilst mouldy or otherwise damaged malt culms should be entirely rejected. See BARLEY, BREWERS' GRAINS, DISTILLERS' GRAINS. [C. C.]

Maltese Dog.—This attractive little dog, which for some obscure reason is referred to by

Maltese Dog

many people as a Terrier (to which variety of the canine race it has no resemblance whatever), has never been largely bred in this country, and of late years possesses fewer supporters than ever. It is a delicate, fragile little creature of about 10 lb. weight, and always of a pure-white colour, any markings, such as a lemon tip to the ear, being a bad fault. The coat, which is another of its chief points, must be free from curl, long, and very silky in texture. The skull is rather wide, and tapers off towards the nose, the eyes being small and black in colour, and the ears, which are set on high, being very small, but all the head properties are concealed by the wealth of hair. The back is short, and the fore legs also, and the tail is carried over the back. The Maltese is purely a toy variety, and a delicate dog to rear, whilst the number of its admirers is so limited that it can scarcely be referred to as a profitable breed to keep. [V. S.]

Maltese Goat.—This, although a small-sized breed, is one of the best for milk, many specimens yielding from 250 to 300 gal. during one period of lactation; whilst some are reported to have given as much as 7 qt. a day. It is probably on this account that the Maltese goats are invariably thin. Although occasionally short-haired, the generality of these goats have long hair, and they are met with of nearly every colour, though those which predominate are reddish-brown, white, and grey, or a mixture of these, whilst a few are spotted. The head is long and thin, the facial line being straight, and there is generally absence of both beard and horns, in the females at least. The ears are slightly pendulous, but often held horizontally, inclining forward. The udder is large, but of an ugly shape, with big coarse teats like small udders in themselves, due probably to a practice of the Maltese goatherds to be referred to further on. In addition to this malformation the udder has a peculiar tint of orange-red and is often covered with black spots, which is indeed noticeable on the skin generally, and is quite a feature of the breed.

There are some 20,000 goats in Malta; but this variety is not restricted to the island, being found largely in Tunis and also in Algeria, though in the hands of the Arabs it is not so good a milker as under the care of the Maltese, who practically live with their goats, and treat them with the greatest consideration and affection. In order to encourage the secretion of milk the goatherd manipulates the udder of the animal for some time each day for a few weeks prior to parturition. This is done by gentle friction with the palms of the hands, using a greasy substance in the process to facilitate this sort of massage. It is believed that by this means greater activity is encouraged in the milk glands, with the result that when the kids are born the flow of milk is augmented. The animal submits itself readily to the operation, which it appears to enjoy. The goatherd milks his goats always from behind, the long pendulous bag being specially adapted to this system.

The Maltese goat has come into bad repute of late years in consequence of the terrible amount of sickness and death amongst the troops stationed in the island, and which was directly traced to the milk of these animals. This disease, however, has been known from time immemorial, and is not restricted to the island of Malta, being common all along the

Mediterranean coast. Moreover it is not goats alone that communicate it, as it may equally be conveyed by cow's milk. The infection is due to a microbe known as *Micrococcus militensis*, which infests the milk in such numbers that in some cases 30,000 have been found in a cubic centimetre of the liquid. It is a singular fact, however, that the goats so affected have frequently all the appearance of perfect health. Goats at one time were constantly being landed in England from Malta, but no case is on record of any person having suffered from drinking the milk of such goats in this country, the climate of Great Britain being said to be unfavourable to the development of the microbe. [H. S. H. P.]

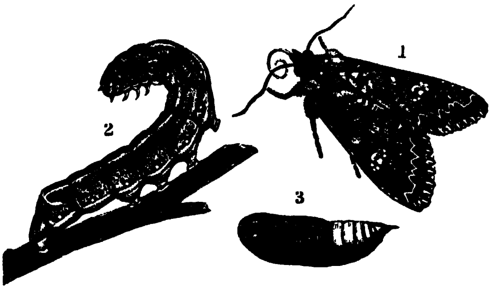
Malting. See MALT AND MALT PRODUCTS.

Maltose. See SUGARS.

Malvaceæ is the botanical name for a nat. ord. of dicotyledonous herbs and shrubs, with petals not grown together, hypogynous stamens, and a superior ovary. The leaves are usually provided with wing-like outgrowths at the base (stipulate), and have lobed blades with ribs radiating from a point (palmatifid). The surface of the blade is often velvety, being covered with star-shaped hairs interesting to microscopists. The flowers are usually large, and invested with special bracteoles which look like an extra calyx (epicalyx). The calyx proper is composed of sepals grown together; it surrounds the conspicuous brightly coloured corolla, composed of five petals twisted round one another in the bud (contorted æstivation). The stamens are very characteristic, for their filaments have grown together so as to form a long tube; at the end of this tube the numerous filaments are free from one another, and each bears a kidney-shaped anther full of spiny pollen grains which are elegant objects under the microscope. The pistil occupies the centre of the flower, and is composed of many carpels the bases of which are grown together to form a many-chambered ovary inside the other parts of the flower. The fruit is dry, and in the British genera it splits longitudinally into pieces (cocci), containing one seed, whereas in foreign genera, such as cotton (Gossypium), the seedcase opens to allow seed to escape. Well-known plants belonging to this order are:—

1. Mallow (*Malva*), with an epicalyx of three bracteoles.
2. Hollyhocks and Marsh-mallows (*Althæa*), with an epicalyx of six to nine bracteoles.
3. Cotton (*Gossypium*). In this genus the fruit opens to allow seed to escape (capsule fruit), and the seed itself is clothed with long hairs for wind dispersion. These hairs are the cotton of commerce. The body of the seed yields cotton oil, and the crushed residue forms cotton cake. [A. N. M'A.]

Mamestra brassicæ (the Cabbage Moth), an insect from whose attacks we suffer every summer and autumn in gardens. The caterpillars will feed upon almost all plants, but are particularly harmful to cabbages and cauliflower. They eat their way into the heart of the cabbages and riddle them with holes, and in addition their wet green 'frass' fouls them and renders the crop useless for market. The moth lays her eggs on the leaves, and the larvæ hatch in a few days and at once commence to feed. The colour is green at first, but as they grow they become very variable in hue; some are green and black above, some blackish with flesh-coloured markings, others pale dusky green, a dark broken line along the back, often pale on each side, and with a pale side line. They roll themselves into a tight ball when disturbed, and when mature they change to a chestnut-brown pupa in the earth, where they remain all the winter. The moth appears from the end of May on to July; the fore wings are rich-brown, variously marked with dark circles and streaks and a large ear-shaped spot, with a white border edged with dark-brown; the under wings are pale-brown at the base, dark towards the outer border.



Cabbage Moth (*Mamestra brassicæ*)

1, Moth. 2, Caterpillar. 3, Chrysalis.

Treatment.—Cabbages may be dusted with powdered lime; this works into crevices where the caterpillars are, and kills large numbers. Miss Ormerod has recommended using gas lime after being exposed to the air for some time. When the beds are being dug over, the brown pupæ should be collected and squashed. Fowls eat them, and might under certain circumstances be turned on to cabbage fields when being cultivated. [F. V. T.]

Mamestra persicariæ (the Dot Moth), a widely distributed moth in Britain and the rest of Europe. The mature insect is about $1\frac{3}{4}$ in. in expanse of wings; the fore wings are a rich dark-brown varied with rusty colour, with small paler spots at the tips and near the hind edge, and a conspicuous white dot on the wing surface; the hind wings are pale grey-brown, with a dark smoky area around the edge and dusky nervures. It appears at the end of June and in July, and is nocturnal in habits. The female lays her eggs in groups of twenty to forty on the leaves of plants which will serve as food for the larvæ. The food plants are lilac, ivy, plum, poplar, gooseberry, raspberry, rose, clematis, and currants; also lettuces, mint, parsley, various garden flowers as geranium, marigold, sunflower, and many low-growing weeds. The caterpillar reaches $1\frac{1}{2}$ in. when full grown. It is pale olive-green or reddish-grey in colour; a pale line runs down the back; on each side of this line, beginning at the fourth segment and going on to the

eleventh, is an oblique dark mark on each side of each segment, slanting backwards, thus the pairs forming V-shaped marks—the first one or two are the darkest; beneath there is a wavy white line, and under this five pale oblique bars, of which four run down to the sucker feet. The caterpillars are found in September and October, and feed very ravenously. The pupal stage takes place in the ground.

Treatment.—Where they occur in numbers on fruit bushes, or even apple and plum, they may be destroyed by arsenical sprays. On roses and garden plants they are best coped with by hand picking. [F. V. T.]

Mammals, warm-blooded hairy animals which give milk to their young. They are quadrupeds, except in the orders Cetacea and Sirenia; they have two occipital condyles; the lower jaw is one bone on each side and articulates with the squamosal; the vertebræ and long bones have almost always terminal caps or epiphyses; except in Monotremes the coracoid is represented only by a small process from the scapula; and there are many other skeletal peculiarities. There are usually convolutions on the cerebral hemispheres; the heart is four-chambered; the fully formed red blood corpuscles are non-nucleated; there is a muscular partition or diaphragm between the chest and the abdomen; the ureters open into the bladder except in Monotremes; and there are many other peculiarities in the soft parts. All are viviparous except the Monotremes, which lay eggs.

There are three grades of mammalian evolution: (*a*) The Monotremes, including the Duckmole (Ornithorhynchus) and the Spiny Ant-Eaters (Echidna), are oviparous, the eggs being hatched outside the body. The brain is poorly developed; the pectoral girdle shows a coracoid reaching the sternum; there is a cloaca into which rectum, ureters, and genital ducts open. The temperature is low and markedly variable. (*b*) The Marsupials, including kangaroos and bandicoots, phalangers and opossums, bring forth their young prematurely after a short gestation, during which there is no true (*i.e.* allantoic) placenta except in a few cases. Most female Marsupials have an external pouch, to which the tender young are transferred, and within which they are nourished and protected for some time. (*c*) The Placentals, including all the other mammals, have a well-developed placenta uniting the unborn young to the mother, and in most cases the brain is much better developed than in the most intelligent Marsupial.

Among the orders of placental mammals with living representatives the Edentates, Sirenia, and Cetacea are by themselves. The others may be ranked on three great lines: (1) the predominantly herbivorous Ungulates and Rodents; (2) the predominantly carnivorous Carnivora, Insectivora, and Bats; and (3) the series which, beginning with the Lemurs, leads through various grades of monkeys to a climax in Man. [J. A. T.]

Mammitis.—Inflammation of the mammæ or milk-producing apparatus is a common source of loss to all breeders, and arises from a variety of causes. The large and pendulous udders of domesticated animals render them more prone to this trouble than those existing under more natural conditions, and not bred by selection for deep-milking qualities. External violence, chills, retention of coagula from a previous period of lactation, and bad management in drying off, irregular milking, infection through the orifice of the teat when lying down, and specific infection from other animals have been assigned as causes. A most malignant form of infectious mammitis exists on the Continent, and in the year 1908 a considerable outbreak occurred in Cheshire and Salop, but does not appear to have gained a permanent footing. It is important to adopt remedial measures immediately an animal shows swelling or tenderness of the udder, or injury to the teats or skin. A bold aperient dose is considered good treatment, fomentation of the udder (taking much care to dry it afterwards), the inunction of camphorated oil, and the careful stripping of the gland at frequent short intervals. Under the title of GARGET this subject is more fully considered. [H. L.]

Mammoth Clover, a form of Red Clover which is more durable, taller, and of stouter growth than the Common Red Clover. The flower-head is somewhat stalked, and the plant bears larger and darker heads, and matures later. It is more productive, is better than Common Red Clover for enriching soils; but it yields a coarser hay, and is not so much relished by stock. See CLOVERS.

Mammoth or Big Tree (*Sequoia gigantea*) is the largest known species of tree, attaining nearly 400 ft. in height and from 30 to nearly 40 ft. in diameter for the giant trees of great longevity in the national parks of California. The genus Sequoia, consisting only of this and another species (*S. sempervirens*, see art. on REDWOOD, CALIFORNIAN), both indigenous to the mountains of California, belongs to the Taxodineæ family of the nat. ord. Coniferæ. The leaves of the Mammoth tree are evergreen and are spirally arranged; each is shaped like a narrow, shallow, pointed boat with a prominent keel on the lower face; some are pressed close to the shoot, while others have their sharp ends spreading out; and the stomata are marked by dots of white wax on the upper and under surfaces. The male and the female flowers are minute and solitary, occurring on the same individual. The oval cone, 2–3½ by 1½–2¼ in., ripens in second year; and each cone scale, bearing 4 to 9 winged seeds, has at the thickened end a central pit, often with a distinct prickle. The red-brown bark is very soft and thick (over 2 ft. thick in California), and the wood is soft, brittle, and very light (sp. gr. 0·38 seasoned). In Britain it is of no value as a forest tree, being merely an interesting exotic of very rapid growth, with quaint foliage and a very conical, strongly buttressed habit of growth; and it is far less beautiful in parks and gardens than many of the other American conifers. Introduced into Britain in 1853, specimens already range up to over 100 ft. high and 15 ft. in girth. It thrives best here on a deep

dry soil and in an open but sheltered situation. It can be grown from cuttings, which root easily, but better plants are got by sowing on seedbeds and transplanting one-year seedlings into nursery lines, where they should be put well apart as they grow quickly and need a free space. [J. N.]

Management of Farms. See art. FARM MANAGEMENT.

Management of Stock.—Full details as to the management of live stock will be found in the separate articles dealing with the various breeds of cattle, horses, sheep, pigs, poultry, &c.

Management of Woodlands. See art. WOODLANDS, MANAGEMENT, PROTECTION, AND UTILIZATION OF, and FORESTRY.

Mandioc, the synonym for Cassava, a shrubby plant extensively cultivated in tropical countries for its large, fleshy, underground tubers. See CASSAVA.

Maned Sheep, a race of sheep confined apparently to the forest regions of West and West-Central Africa, and domesticated by the negroid peoples of Liberia, Nigeria, and adjoining countries. They stand at least as high as large English sheep, but are usually more lightly built, with a finer carriage and longer legs. The coat, moreover, at all seasons and ages, consists of coarse hair, which in the rams forms a decided mane, particularly abundant and long upon the throat and also upon the nape and shoulders. The tail is long and cylindrical, and there are no fatty accumulations either upon that organ or upon the rump or head. The prevailing colour is white, diversified with black patches, especially upon the head and legs. The ears are long and pendulous, and the nose is markedly arched, especially in the rams. The ewes are hornless; but in the rams the horns are of considerable size and length, and often extend laterally from the sides of the head, presenting a gimlet-like spiral twist, with the points projecting outwards. In allusion to its mane, this sheep has been named *jubata*. The mane, however, is not always well developed; and some of the rams kept by the Haussa tribes differ from the typical maned breed above described, not only in sometimes wanting the long hair upon the neck, but also in colour, the posterior part of the body being white and the head and forequarters roan, resulting from an intimate mixture of white and brown hairs. According to Sir Harry Johnston the dwarfed Cameroon sheep, perhaps the smallest of existing breeds, with the exception of the true St. Kilda or Hebridean race, is merely a variety of the maned sheep. It also has black markings upon the legs and face, but the rest of the body, with exception of the belly, which is black, is a fairly uniform light brown. It is said to be nearly, if not quite, hornless—a character which, like its diminutive size, must be regarded as indicative of degeneration. The name *pygmæa* has been given to it on account of its smallness of stature. [R. I. P.]

Mane of Horses.—As probably every observant member of the community will have satisfied himself, the mane of a horse usually falls over on the off side of the neck; but it is the custom to train those of cavalry remounts to lie on the near side, as it thereby affords assistance to troopers when remounting. As regards the treatment of the mane there is not much to be said beyond that it ought not to be cut, the correct way of thinning or shortening it being by combing from the under side. If the upper part is combed or cut, unsightly notches often appear, and hence the advice given above. Many owners of cobs and ponies, and also some of full-sized horses, advocate hogging the manes of their animals—that is, cutting them so short that they stand upright, the hairs in the centre being longer than those on either side. One advantage of this practice is that it ensures the groom attending properly to the cleansing of his charges' necks, which in the case of careless servants are often in a very dirty condition under the mane, and especially at the roots. When the mane of a saddle horse is hogged, a small tuft of hair may be left near the withers to assist his rider when mounting. [V. S.]

Manganese is a metal, and occurs widely distributed in nature as the oxide. It is found in the ash of many plants in small quantities. The part it plays in plant growth is little understood. Small quantities have been shown to have a stimulating action upon the growth of cruciferous plants, maize, barley, oats, rice, peas, &c. In some pot experiments, using ·015 per cent of a manganous salt, considerable increases were obtained in the straw and grain of peas, lesser with barley. If much manganese salt is present a harmful effect results. The manganic are more toxic than the manganous salts. The presence of manganese salts in plant tissues may have some important connection with the action of oxidases in plants. Much attention has of late been devoted to the relationship of the rarer elements, including manganese, to plant growth. Soaking seeds in solutions of the salts of the rarer elements previously to sowing have had interesting effects on germination. This line of work, however, is only in its infancy. [R. A. B.]

Mange, a parasitic disease of the skin affecting horses, cattle, and dogs, and known as scab in the case of the sheep. There are three chief genera of mange mites, namely *Symbiotes*, *Dermatodectes*, and *Sarcoptes*. The first-named live upon the surface, supporting themselves upon the debris which they do nothing to produce, save for the provocation of the host, who rubs and scratches. The second (Dermatodectes) puncture the skin to obtain their food; while those of the genus Sarcoptes burrow through the surface, the females depositing their eggs at the end of long galleries, where it is difficult to dislodge them. The difference in the habits of the various mange parasites will readily account for the ease with which some are destroyed, and the extreme difficulty experienced in eradicating others. Sarcoptic mange, when it attacks wild horses or the semi-wild upon mountain sides, often decimates them before it can be arrested, or spends itself by having destroyed its victims. Only by microscopic examination can the kind of mange be determined;

and this should be ascertained as soon as possible, as we can then predict an early cure or make arrangements for treatment, which must extend over a considerable period. It is a very generally recognized fact that mange is a disease of poverty, and that debilitating influences invite attack, and the presence of parasites afterwards renders such debility permanent until a cure is effected. General Fitzwygram says, in his useful work on Horses and Stables, that 'mange never occurs in healthy, well-groomed, well-fed horses. It is a sure sign of neglect and dirt, or of injudicious feeding, or of bad management of some sort. The owner will do well to change his servants whenever the disease appears in his stable.' This is too severe on the servants, as we know of many cases where horses have had all the conditions prescribed by the General, but have taken mange from a headstall or halter, or from the fittings of a bait stable whose proprietor could not prevent being temporarily infected. The mange parasites are too small to be seen with the naked eye, and the irritation provoked may easily escape the most observant groom until considerable mischief has been produced. A rug or other article thrown over a horse, or any portion of harness, may be the medium of contagion; and in every animal, no matter how well groomed, there will always be dandruff which the currycomb and the dandy-brush fail to dislodge. If any horse's mane is turned over, or the coarse hairs of the tail held up, the observer will see scales, which to the mange mite are as large as labourers' cottages to a man, and in these they find sanctuary and reproduce in vast numbers in an incredibly short time, especially if the weather is warm. Mange affects all animals, the wild rabbit and the fox not excepted, and many a hunting country is ruined for a season by weak mangy foxes which afford no sport. Domestic swine, so subject to lice and other parasites of the skin, do not suffer from mange to any extent. Examples have been found by the most careful search on the part of Continental veterinarians, but so far as this country is concerned we may practically except the pig from the list of species liable to mange. The mane and tail, the poll, the shoulders, and arms, offer most attraction to the mange parasites in horses and cattle, and in the first-named positions they often defy remedies that are not very vigorously employed. Besides the mange parasites which have for their habitat the body generally, there are symbiotes confining their attention to the lower portions of the limbs of horses and cattle, seldom producing their ill effects above the knees and hocks. These call for special attention, as many so-called cases of grease in horses are due to the irritation of symbiotes whose inclination is to remain quiescent during the day and provoke the host during the night, when he stamps and rubs one leg over the other, causing that broken 'feather' which is such a detriment to horses of the Shire breed. The smaller animals—dogs, cats, ferrets, &c.—are troubled by the *Symbiotes auris*, whose movements in the meatus give rise to irritation, and cause these animals to strike the base of the ear with the hind foot (see CANKER OF THE EAR). Mange is one of the most troublesome of skin diseases among dogs of every breed, and often mistaken for eczema. The parasites in many instances remain more or less quiescent in the coarse hairs of the elbow points and hock, and only when stimulated by warm weather or other circumstances spread to the adjacent nearly nude skin, when their irritation excites scratching, and the serosity thus produced is thought to be the product of vesicles which have coalesced and broken. Such cases are commonly treated with emollient ointments or lotions, which fail to destroy the parasites. The *Demodex folliculorum* is the most difficult of all the mange tribe to deal with, and many dogs are destroyed as incurable. Success, however, frequently attends the administration of sulphur baths, dressing with a 3-per-cent solution of chloride of zinc, squeezing out pustules and cauterization of the interiors, washing the squamous variety with soft soap, and the application to limited areas day by day of the following lotion: Salicylic acid, ½ oz.; methylated spirit, 3 oz.; tincture of cantharides, ½ oz.; and castor oil, 4 oz. In many cases of mange in the larger animals the area infected is quite circumscribed, and may be cured by remedies which would not be safe to employ over a large surface, for fear of absorption. Mercurial ointment, for instance, will be suitable where a collar has infected a horse. When the disease is diffused over the body we must employ agents that are both safe and economical, as a large amount is required for animals with thick coats. A preliminary washing with soft soap lifts the cuticle and enables the chosen destroyer to reach the hiding places of the parasites; and particular attention should be given to mane and tail, and the region round the ear, where a few pregnant females may escape, to continue the race. MacDougall's dip, Cooper's dressing, Jeyes's fluid, or Little's phenyle—any of these preparations or non-arsenical sheep dips are effectual and not too costly; but the harness, tools, rugs, brushes, and all possible sources of reinfection must not be forgotten. See also DEMODEX. [H. L.]

Mangel-wurzel.—The cultivated mangel-wurzel (= root of scarcity, German) is derived no doubt from a variety of the Wild Sea Beet (see art. BETA). The commercial 'seed' which the farmer sows for a crop of mangels consists of clusters of several one-seeded fruits closely joined together, so that from one 'seed' two or more young plants may develop. The true seed is small, black, and kidney-shaped, about the size of a turnip seed, hence the necessity for shallow sowing. The part of the stem below the cotyledons and a certain portion of the primary root soon begin to thicken, and ultimately grow into the familiar fleshy 'mangel'. This 'root' differs from those of the carrot or turnip in possessing not one but several cambium rings, all of which are active at the same time.

In a transverse section of a mangel are seen a series of concentric rings of stringy vascular tissue, between which are alternating rings of soft, thin-walled tissues, the cell sap of which is sometimes coloured yellow, orange, or crimson.

The larger the number of woody rings and

the closer they are arranged, the greater the value of the mangel, for the sugar and other nutrient matter are stored chiefly in this part of the 'root', the soft intervening tissue being much less sweet. The colour of the flesh is no guide to the quality of the root.

In the first year of growth the primary stem remains short, the leaves upon it being crowded together. The leaves are smooth, entire, without the protecting glaucous bloom of the cabbage and swede, and on a hot day transpire water so freely that 'wilting' or withering takes place; the plant, however, recovers in the night.

In the second season an erect branched stem is produced, upon which are borne flowers in sessile clusters. Each flower is bisexual, with a green five-leaved perianth, five stamens, and an ovary containing a single ovule; the wall of the ovary when the fruit is ripe becomes hard and woody.

A number of varieties of mangels are known. They vary in shape of root and in colour of skin, which may be yellow, orange, purple, or crimson. Very frequently the colouring matter of the skin is seen in the veins of the leaves and in the soft zones of the flesh.

The ordinary division into (1) Long, (2) Intermediate, (3) Tankard, and (4) Globe varieties is convenient. Sudden sporting, reversion to ancestral form, natural tendency to variation, and crossing with other varieties render it difficult for seedsmen to keep their types 'true' in respect of shape and colour of flesh, without constant roguing and destruction of objectionable forms.

The *Long* varieties are three or four times as long as broad, tapering, with yellow, red, or purple skin. They are suited to deep soils, and grow to a very large size when well manured, although they are watery and poor in feeding value. To this class belong the bent *Oxhorn* varieties now rarely grown.

The next smaller in size are the *Intermediate* or *Gatepost* varieties, which are intermediate in form and size between the long and globe kinds.

The *Tankards* have small cylindrical roots of exceptional quality, often having twice as much sugar in them as those already mentioned.

The *Globe* varieties are roughly spherical, and grow well out of the ground. In point of quality they rank next to the Tankards, and, like the latter, are adapted for cultivation on the lighter and shallower classes of soil. [J. P.]

No crop has increased in popularity so rapidly as the mangel, and the official Agricultural Returns prove that it has largely replaced other root crops in the rotation. Within the last thirty years the area has increased in the United Kingdom by over 75,000 ac., and now 500,000 ac. are annually devoted to the mangel crop.

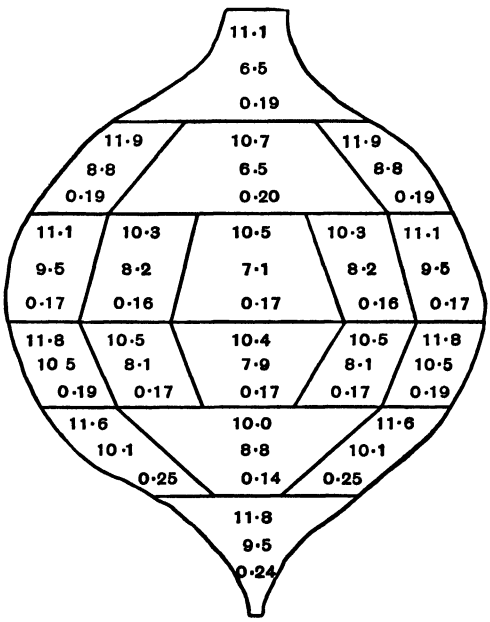
The popularity of the mangel as a farm crop is no doubt due to the fact that it yields a greater weight of feeding matter per acre than any other crop of its class; and as it suffers less from insect and fungoid attacks and withstands drought, it is in many parts of the country a safer crop to grow than swedes or turnips.

Composition and Feeding Value.—The composition of mangels varies within certain limits according to type, soil, manuring, method of growth, climate, season, size of roots, &c.

	Average Percentage.	Limits of Variation, per cent.
Water	88	85·0 to 92
Nitrogenous substances	1·1	0·7 to 1·6
Non-nitrogenous:	10·0	6·0 to 17·0
Fat ... ... 0·1		
Sugar ... ... 8·9		
Fibre ... ... 1·0		
Ash	0·9	0·8 to 1·2

The different parts of the root are found to vary in composition. In a horizontal section of a mangel some eleven or twelve rings will be seen, which have taken about fifteen days each to form, and of these the outer rings contain the larger percentage of dry matter. Small roots contain, on an average, less moisture than large ones.

The following figure by Wood and Berry shows the variation in the percentage of dry matter, the percentage of sugar, and the percentage of nitrogen in the various parts of the root.



In each division the upper figure represents dry matter, second figure the sugar, and the lower figure the nitrogen per cent (Wood and Berry).

The feeding value of the mangel lies in the dry matter which the root contains; and though for comparative purposes the total dry matter is usually accepted, the true value depends upon the proportion of digestible constituents. This proportion varies, not only in different varieties of mangels, but also in the same variety under different conditions of growth. The dry matter consists of about two-thirds sugar, together with

cellulose, proteids, amides, and a small amount of ash. Little has been done in the way of increasing the proportion of valuable constituents in the mangel during the last fifty years, whereas in sugar beet the yield of sugar has by selection been increased nearly 100 per cent.

The feeding value of the chief types may be compared in the following table:—

Name of Type.	Yield of Crop, per acre.	Yield of Dry Matter, per cent.	Yield of Dry Matter, per acre.	Yield of Sugar, per cent.	Yield of Sugar, per acre.
	tons		tons.		tons.
Yellow Globe	29·9	10·7	3·20	6·3	1·88
Golden Globe	25·0	13·4	3·35	8·2	2·05
Golden Tankard	24·6	13·1	3·22	8·0	1·96
Intermediate	27·4	12·0	3·29	7·1	1·94

Taking the dry matter as the valuable portion and comparing the different varieties of mangels, it will be seen that Golden Globes and Golden Tankards have a higher feeding value than Intermediates and Yellow Globes. Experiments at the Midland Agricultural College and the Harper Adams Agricultural College have shown this to be the case in feeding to stock.

Mangels are essentially a cattle food, whereas for sheep they are not the most suitable food except in the case of ewes and lambs. For milk production the mangel is an excellent food after being stored and allowed to 'ripen'. When fresh, mangels have a tendency to scour stock, but during ripening the dry matter undergoes a change, pectin and pectose become changed to soluble sugar, and amides into albuminoids.

The keeping qualities of mangels add very considerably to their value, as they provide a succulent food in the spring and early summer months of the year when such foods are scarce. For milk cows an ordinary allowance is from 40 to 50 lb., and for fattening stock ¾ to 1 cwt., per head per day. Mangels are best fed to milking and store cattle when pulped—the moisture set free being taken up by the large amount of chop usually given to that class of stock—but for fattening animals, cutting into 'fingers' is preferable, as less moisture is set free.

Consuming value per ton varies from 5*s.* to 8*s.*; but the market value, especially near large towns where cow-keepers set great store on mangels for milk production, the price in the spring months may reach as much as 20*s.* to 22*s.* per ton.

Soils and Climate.—Mangels can be grown on most soils, but deep rich loams are considered to yield the largest crops, and for the 'long' varieties a deep soil is essential. Globes, Tankards, and Intermediates can be grown on shallower and lighter soils, but heavy crops are produced with these varieties even on clay soils. The warm and somewhat dry climate of the Midlands and south of England appears to favour the mangel best. Sunshine is an important factor in the growth and ripening of mangels, and after the plant is well up, mangels can stand drought better than any other root crop.

Seed and Cultivation.—The actual germinating capacity of mangel seed varies considerably with the character of the weather during the season of growth and the treatment of the seed-producing plants. Seed may be produced from transplanted matured bulbs or from immature bulbs produced late in the season and left in the ground all the winter, protected from frost. In estimating the value of seed, the fact must be noted that one so-called 'seed', which is in reality a fruit, or capsule, may produce two or three sprouts, and though a large number of sprouts may be seen, the percentage of germinating seeds (fruits) may be small. Only one sprout will be finally allowed to develop into a plant, so that a poor percentage germination will result in many gaps in the field. The germinating capacity should not be less than 120, each capsule containing from three to five seeds.

Age of seed is not so important in mangels as in many other crops, and though some farmers are averse to sowing anything but one-year-old seed, yet five- and six-year-old seed will produce a satisfactory crop. Most seedsmen hold sufficient stocks of seed from year to year to compensate for a bad season, when it may be impossible to harvest seed.

The quantity of seed sown varies from 6 to 10 lb. per acre, according to system of sowing; dibbling by hand, which requires much less seed, is now seldom seen, the usual method being by means of a small root drill.

Sowing is usually done as early in April as possible, except in the south of England, where early sowing is thought to be the cause of 'bolting', or running to seed.

In most cases drilling is done on ridges, which may be from 21 to 29 in. apart; but on light dry soils and with a small rainfall, drilling on the flat is generally preferred. Thinning is done so as to leave plants from 6 to 12 in. apart in the rows. For exhibition purposes it is a common practice to space out plants a yard apart each way in order to obtain large bulbs.

The following table shows the theoretical yield according to the distances apart:—

Distance between Rows.	Distance between Plants	Number of Plants per Acre.	Weight per Bulb.	Weight of Crop per Acre.
in.	in.		lb.	tons. cwt.
21	10	29,743	4	53 2
	12	24,786	4¼	47 0
	14	21,245	4½	42 15
24	10	26,114	4¼	49 11
	12	21,762	4½	43 17
	14	18,653	4¾	39 10
27	10	23,212	4½	46 12
	12	19,344	4¾	40 2
	14	16,580	5	37 0

On one sewage farm the system is to plant mangels in double rows about 1 ft. apart, with about 16 in. between the double rows. The plants are left very thick, and a small solid root is thus obtained. The crop is stated under this system to amount to about 80 tons per acre.

The seed should not be sown deeper than $\frac{3}{4}$ to 1 in., and ridges should be rolled when perfectly dry after sowing, especially if the soil is loose and open.

Steeping the seed in water for some hours before sowing is frequently done, in order to soften the seedcase and so hasten germination.

Preparation of the land has much to do with the success of the crop. Mangels are a cleaning crop, and usually follow wheat in the rotation. If the land is very foul, autumn cultivation is specially advisable, and as much cleaning and removing of weeds as possible should be done. During the winter, as weather permits, 'long' or 'raw' dung is carted out and ploughed in. The aim should be to obtain a good deep mellow tilth, and in dry districts to retain as much soil moisture as possible. For this reason spring cultivations should be directed towards getting a fine seedbed; and if the land is cleaned in the autumn, scuffling or cultivating, followed by one or two harrowings and rolling, will be sufficient before ridging up. When dung is applied in the spring it can be done in the ridge, but the dung used should be well rotted. Any artificial manures can also be applied in the ridge, after which the ridges can be split back ready for sowing the seed.

The young plants will appear in from ten to fourteen days, and as soon as they are well above ground, cleaning of the land should commence. Repeated horse hoeing is required to keep the weeds down between the rows. As soon as the plants are well established, which takes from four to six weeks from the time of sowing, the process of 'singling' should commence. From the table given above it will be evident that bad work at this stage will seriously affect the ultimate yield. Care in selection of the plants to be left is more important than uniform distance between, as weakly plants will only produce stunted bulbs, whereas in good work a single, strong, healthy plant should be selected.

'Bunching' consists in cutting out plants in the row and leaving a small bunch of plants at the required distance. It is a practice adopted when growth is taking place rapidly and there is not sufficient time to select the best single plant.

Horse and hand hoeing are repeated until the leaves extend so far as to be liable to be damaged, and by this time they will smother down any weeds between the rows, and in dry weather help to retain soil moisture. A wet or dropping season is generally a more expensive one, as more work is needed in keeping down the weeds.

Manuring.—The basis of manuring for mangels is usually a dressing of farmyard manure, and without it there is generally a difficulty in obtaining a satisfactory 'plant'. This may be partly accounted for by the action of dung upon the texture of the soil, and further, dung enables the soil to retain moisture, which is an important factor in the early growth of the young mangel plants.

While dung is essential, it is more profitable to apply smaller dressings of farmyard manure along with artificial manures, than to apply heavy dressings of farmyard manure alone. It is a common practice in many parts to apply all the available dung to that portion of the root land upon which mangels are to be grown, and to use only artificial manures for the swede ground.

The general conclusions arrived at from the large number of experiments conducted all over the country are:—

1. That a dressing of dung does not supply nitrogen sufficiently rapid for the needs of a large crop, and therefore dressings of a quick-acting nitrogenous manure are essential. It has been found by experiment that the amount of nitrogen actually recovered by the crop is about 75 per cent of the total in the case of nitrate of soda, 50 to 60 per cent in sulphate of ammonia, and only 30 to 40 per cent in the case of dung. The nitrogenous manure is best applied in successive dressings during the period of growth. In most combinations of manures the larger portion of the nitrogenous manure given as nitrate of soda yields the best results.

2. That phosphatic manures do not give such an appreciable return in mangels as in swedes, and should not be used without a potassic manure. Superphosphate is the more generally used phosphatic manure, and in a series of experiments at the Harper Adams Agricultural College very satisfactory results have been obtained by applying superphosphate as a topdressing in conjunction with nitrate of soda.

3. Potash and other alkaline salts are essential to the proper development of the mangel, and even in soils comparatively plentiful in potash a dressing of one or other of the potash manures gives an economical return. Particularly is this the case where heavy dressings of dung and nitrogenous manures have been used. Potassic manures appear to produce better results with sulphate of ammonia than with nitrate of soda.

4. That as the mangel is descended from a seashore plant, the addition of common salt to the manurial dressing is largely advantageous, if not essential. Profitable results have been obtained by the application of 5 and even 10 cwt. of salt per acre on land which has not received a dressing for some time. In the case of such dressings it is essential to apply salt early, so that it can be well worked into the soil before the seed is sown, otherwise there is a risk of damage to seed. The late Dr. Voelcker believed that the action of salt in increasing the crop was principally due to its liberating other minerals in the soil and rendering them soluble and assimilable by the plant, and that the action therefore was indirect.

In the case of profitable mangel soils the following is a suitable dressing per acre:—

Dung, 12 to 15 tons.
Superphosphate, 5 cwt., or dissolved bones, 4 cwt.
Kainit, 3 cwt., or sulphate of potash, 1 cwt
Nitrate of soda, 2 cwt., in two or three applications.
Common salt, 5 cwt.

The first application of nitrate of soda should be immediately after singling, and the subsequent dressings at intervals of two to three weeks.

It is a practice in some parts to apply ½ to ¾ cwt. of sulphate of ammonia along with the superphosphate, instead of part of the heavy dressing of nitrate of soda.

In all questions of manuring and the use of salt the effect of season is very marked, but it would appear that with a complete manuring this effect of season is not so noticeable as with partial dressings.

A very useful summary of the results of experiments upon the manuring of mangels carried out at the various colleges and experimental stations has been prepared and published by the Board of Agriculture and Fisheries.

HARVESTING.—The lifting and storing of the mangel precedes other root crops, and the latter part of October is the usual time, except in the south, where harvesting goes on well into November. Pulling by hand is done and the leaves are sometimes twisted off (or when cut it should not be done too closely), leaving the rootlets untouched; the object being to prevent loss of sap, or what is popularly spoken of as 'bleeding'.

Mangels are very liable to be damaged by frost, and consequently must be lifted before frosts are likely to occur; and in storing, any danger of frost reaching the roots must be guarded against. Pitting, or clamping, in the field is the system generally adopted. A shallow trench 6 to 8 ft. wide is dug, and the roots are piled into a triangular form and a thin layer of straw laid over. In a few days' time a layer of soil from around the clamp 5 or 6 in. deep is placed on the straw to within 2 ft. of the top to allow of ventilation, and in two or three weeks' time this is also covered over. The trench around the clamp from where the soil has been removed serves for drainage. Mangels stored in this way will keep safely until the following summer.

Other methods of storing include piling the roots to a depth of 7 or 8 ft. against a high wall and putting on a covering of bracken or straw to the thickness of 12 in., and thatching so as to throw off all rain and snow.

YIELD.—The yield per acre will, of course, vary with soil, climate, variety, manuring, and method of cultivation. The Agricultural Returns for 1908, published by the Board of Agriculture and Fisheries, give the estimated yield per acre as follows:—

England	21·06 tons.
Wales	18·80 ,,
Scotland	21·47 ,,
Great Britain	21·01 ,,

On sewage farms in suitable seasons the crop may be as high as 100 tons per acre, and on good mangel soils under generous treatment and in average seasons the yield will vary from 40 to 60 tons per acre with such varieties as Yellow Globes' and 'Intermediates'.

'BOLTING' OF MANGELS.—Mangels, though originally annuals, are now regarded as being essentially biennials, and should in their first year of growth lay up a store of nutriment in the root which in the second year will provide means of producing seed.

It is often noticed that a number of plants produce seed stems in the first year, and these are termed 'bolting roots' or 'runners'. Numerous theories have been put forward to explain the cause of 'bolting', such as climate; season (in a wet year the proportion of 'runners' is much higher); time of sowing; manuring; seed; variety: for instance it is generally noticed that 'Globes' have the least proportion, while 'Tankard' and the 'Intermediate' types have a large percentage of 'runners'.

There is a difference in the composition of a bolted mangel to that of a normal bulb. An average of a number of analyses gave the following figures: Sound bulbs, 8·7 per cent of sugar; bolted bulbs, 5·64 per cent of sugar.

Runners should be cut down early, as the bulb does not further develop, and the formation of seed robs the ground considerably for no purpose. [P. H. F.]

Mangel-wurzel, Insect Enemies of. —Mangel or Beet Fly (*Pegomyia* or *Anthomyia betæ*).—The damage is done by the larvæ burrowing in the tissues of the leaves and living upon the juices, so weakening the plant and destroying the leaves. The attacks are usually repeated, and are very injurious to the crop. See PEGOMYIA.

Wireworms, centipedes, and millipedes attack the young plants and at times completely sever the slender roots; rooks in searching for wireworms pull up the young plants.

Surface Caterpillars (*Agrotis segetum* and *A. exclamationis*) frequently attack the young root just below the surface of the soil, and, biting through, frequently kill the plant. In the older roots they bring about uneven growth and distorted bulbs, and burrowing into the roots so injure them that they become rotten. See AGROTIS.

Leather Jackets, the larvæ of the Daddy-long-legs (*Tipula oleracea*), attack the young bulb in the same way as wireworms.

Beet Carrion Beetle (*Silpha opaca*).—The leaves are devoured by the larvæ of this beetle, and in bad attacks even the roots near the surface are attacked. See SILPHA OPACA.

Silver Y Moth (*Plusia gamma*).—A pest which, though more or less always present, yet seldom is in sufficient numbers to do damage. The leaves are eaten by the caterpillars, and in bad attacks the plants may be completely stripped of their foliage. See PLUSIA GAMMA.

Pigmy Mangel Beetle (*Atomaria linearis*).—This species occasionally does great harm to the crop. The insects live in the soil and destroy the parts of the young plant below the surface of the ground. See ATOMARIA. [P. H. F.]

Mangel-wurzel and Beet.—Parasitic Fungi.—The fungi destructive to mangel and beet may be conveniently divided into two groups: those likely to be observed on young plants, and those affecting tubers.

FUNGI DESTRUCTIVE TO YOUNG PLANTS.—Downy Mildew (*Peronospora Schachtii*) destroys

the leaves, especially in damp weather; the leaves after bearing numerous tufts of summer spores, dry up and fall, carrying into the soil the winter resting-spores (see 'Phycomycetes' in art. FUNGI). Rust (*Uromyces betæ*), one of the Uredineæ, appears on seedlings as yellowish spots bearing groups of æcidium-cups; somewhat later the uredospores cover the leaf surface as a brown dust, and still later the pustules of dark-brown teleutospores appear. Leaf Spot is caused by a destructive fungus (*Cercospora beticola*) which forms brown spots with a reddish margin; the leaves are ragged and curled at the edges, and ultimately become black and stand upright in a characteristic way. In the endeavour to keep up a supply of fresh leaves the neck of the plant frequently elongates considerably, the 'root' being stunted.

Treatment.—Spray with Bordeaux mixture of medium strength, or with Strawsonite, before thinning and after; this spray fluid is the same as used for potato spraying. All dead leaves, &c., should be ploughed in deeply. As seed may carry spores, a steep is sometimes used: copper sulphate 1 lb., washing soda 1 lb. dissolved in 10 gal. water; the seed is steeped for twelve hours, then dried before sowing.

DISEASES OF 'ROOTS'.—Scab, resembling common potato scab, frequently damages beet. Some observers say that the fungus concerned is the same as potato scab fungus (*Oospora scabies*); if so, then land with scabbed potatoes will produce scabbed beet and mangels. Tumour is a form of scab resembling the black scab of potato, but the fungus is distinct, and the one crop will not infect the other. Heart Rot is recognized by the leaves becoming soft near the base and falling over while still green; the crown becomes brown and rotten and cracked on the outside; the cause is uncertain.

Treatment.—The general treatment is similar to that for land with turnip disease (see art. FINGER-AND-TOE). Only sound 'roots' should be lifted for consumption or storage; diseased 'roots' should not be removed, but with leaves, &c., be ploughed in deeply. The land being infected, should not be used again for this crop until it has been treated with lime and cultivated with other crops. [W. G. S.]

Manger.—This is the part of the stall, whether of ox or horse, set apart for holding the food that is given to the animals at stated periods. It is usually in two divisions—one for the grains and other concentrated foods, another for the hay and straw that serve as fodder. In the cattle stall the manger is a simpler affair than in the stable stall. The ox gets so many roots at a time that a fair-sized trough is required to contain them. Very often this trough is all the furnishing the stall has—roots, cake, grains or meal, and fodder as well being in turn deposited therein. Sometimes, however, a fodder rack is fitted up above this trough. There seems to be no fixed rule for the position of the trough relative to the floor level. In one place it sits on the floor; at others it is more or less elevated. The cattle stall being for two, the trough is usually a joint affair, the rack is nearly always so. The trough is met with constructed either of wood, stone, or cement (iron now and again); best of all, perhaps, is the glazed fireclay trough. The stable manger consists of the corn box and fodder rack. When the rack is an overhead one (replenished from a loft running the length of the stable) the corn box is often developed into a trough extending from travis to travis of the stall. But up-to-date farmers for several good reasons object to stable lofts. Where these are done away with, the rack is more conveniently filled when it is placed level with the corn box. In this position it appears to suit the horses better too. They prefer to eat with head down—thus there is not the same risk of seeds getting into eyes and ears that exists in connection with the overhead rack. The rail that stretches across the front of the stall fastened at each end to a travis does double duty as front top edge to both rack and corn box, and point of attachment for the ring through which the animal's halter plays. It is from 3 ft. to 3 ft. 6 in. above the floor and 18 in. or so from the wall. The corn box takes up from 18 in. to 2 ft., and the remainder of the 6 ft. that go to the breadth of the stall is occupied by the fodder rack. The rack is sparred in front and on bottom. It slopes back, and is kept 6 or 9 in. above the floor. A spar or iron rod fixed halfway along from top rail to wall prevents the horse throwing out the fodder before it settles down to eat it as it comes. In the farm stable the corn box is placed at the off side of the manger, which arrangement allows the hungry horse to begin eating while the ploughman is removing its harness. It is not necessary here to describe the more complicated and expensive fittings of higher-class stables than serve the purposes of the rent-paying farmer. [R. H.]

Mango (*Mangifera indica*, Linn., nat. ord. Anacardiaceæ).—The Mango or *Am* is an evergreen tree of the tropical Himalaya and lower hills of India. It has been known and cultivated practically all over India from the most ancient times. It may be raised from seed, but the better qualities are perpetuated by inarching. The Mango requires a deep well-drained soil, but appears indifferent as to its composition—good fruit is known to be regularly produced from trees grown on river deposits, clay soils, sandy soils, or even on soils highly charged with lime nodules. Seeds are sown in pots, and at the commencement of the rains the pots containing the seedlings are fixed on to the branches of a desired tree, so as to facilitate the cut surface of each seedling being brought in contact with the corresponding surface of a shoot. By the close of the rains the graftings will be complete, and the new plants are then severed and planted out. For that purpose they should be deposited in specially prepared and richly manured holes 20 ft. apart. In five years the plants thus obtained should begin to bear. The flowering season is from January to March, and the fruiting from May to August according to locality.

There are numerous races or cultivated forms of this truly delicious fruit, the two most noted localities being, however, Mazagon at Bombay, and Malda in Bengal. Besides being exten-

sively eaten as fresh fruit, numerous special preparations are made. When half-ripe, after extracting the stone, the pulp is cut into slices and cooked in curries, or is made into pickles or worked up into preserves, jellies, &c. Attempts to bring the fresh Mango on the London market at a paying price have hitherto been un-

The Mango

successful, though Mango chutneys and pickles are now well known in Europe. [G. W.]

Mangosteen (*Garcinia Mangostana*, Linn., nat. ord. Guttiferæ), an evergreen tree of the Malay Peninsula, indigenous apparently to the Molucca Islands, is extensively cultivated in some parts of Burma and a few localities of India. In Ceylon, Trinidad, and Jamaica it may be said to have been acclimatized; but, speaking generally, the Mangosteen, though perhaps one of the finest fruits in the world, has yielded less to cultivation than any other fruit tree, and outside the Malay Peninsula can hardly be regarded as successfully grown. A warm, moist, insular climate seems essential, and shaded valleys preferable to open situations. It is propagated by seed, grafting, or inlayering, and requires a loamy well-drained soil, and rich cultivation is essential. The tree begins to bear when from seven to fifteen years old, and may continue for fifty years. The fruiting season is from June to September. It is desirable that until the rind dries and hardens, the fruits should be handled as little as possible if intended to keep or to be transported. They are accordingly cut from the trees, tied together by their stalks into bunches, and packed in baskets. Hitherto the attempt to transport the fruit to Europe has not been satisfactory, and recently hopes have been entertained of greater success with a special preserve.

It is considered the finest of all Eastern fruits. Ships coming from the Straits convey it to Rangoon and Calcutta, but by the time they reach the latter port the fruits have often become bitter through the formation of lines of yellow gamboge between the pips of the fruit. [G. W.]

Mangrove.—The barks of several trees constitute the tanning material of commerce. The following are the better-known species: (1) *Avicennia officinalis*, Linn., Verbenaceæ—the white Mangrove or *bina*. This is a small tree met with in the tidal forests of India and Burma. (2) *Ceriops Candolleana*, Arn., and *C. Roxburghiana*, Arn., Rhizophoreæ—the *goran* Mangrove. These are small trees of the tidal creeks of India, the former more especially of Sind, and the latter of the Sunderbands. The bark of both is extensively used locally as a tan, and about 10,000 cwt. are annually sold at Calcutta. (3) *Rhizophora mucronata*, Lamk., Rhizophoreæ — the *khamo* Mangrove of Mergui and Perak.

Within recent years the effort has been made to organize an export trade in these barks, and to prepare from them an extract ready for use either as a tan or dye, that might be employed as a substitute for Cutch, but the results so far have not been satisfactory. The trees are exceedingly plentiful, and the supply practically limitless. [G. W.]

Manna is a saccharine exudation obtained naturally from several plants, from others on the bark being incised, and from still others through the parasitic action of scale insects. Commercial manna comes mainly from Persia. The list of plants that are known to afford it might be made both extensive and varied, but the following are those better known: (1) *Alhagi maurorum*, Desv., Leguminosæ—*taranjabin* manna, procured chiefly from Khorasan, Kurdistan, and Hamadan, and exported during November to January. It occurs in the form of small round grains procured by shaking the bushes. (2) *Cotoneaster Nummularia*, F. and M., Rosaceæ—*shir-khisht* manna, comes from Afghanistan, Turkestan, and Persia. (3) *Fraxinus ornus*, Linn. (and other species), Oleaceæ—the Flowering Ash—is the chief source of medicinal manna, and is procured through incisions made on the bark. It is frequently designated Calabrian manna. (4) *Tamarix gallica*, Linn., var. *mannifera*, Tamariscineæ, affords the greater part of the Tamarisk manna that comes from Arabia and Persia under the name *gazánjabin*. This is said to exude in minute drops in consequence of the punctures of a minute insect.

For many years the expression 'bamboo manna' denoted the siliceous and colloidal sub-

stance — *tabâshir* — formed within the hollow culms of the bamboo; but recently it has been pointed out that very occasionally a true manna is formed on the male-bamboo (*Dendrocalamus strictus*), produced very possibly by a scale insect, though this has not as yet been recorded; though an aphis feeding on the leaves of *Bambusa arundinacea* has been observed to eject a sweet liquid so copiously as to make the culms below appear polished, much as the linden trees of Europe and the pine trees of India are often seen glistening with a manna-like fluid formed through an insect. [G. W.]

Manorial System.—The manor was a distinctive feature of feudalism in the earlier years of that system of land tenure, and the so-called manorial system has reference to the methods by which the occupancy and cultivation of land were regulated in the eleventh and succeeding centuries until the introduction of leases and money payments abolished the system of service on which it was based. (For the development of the manorial system the reader is referred to the article on FEUDAL SYSTEM.) To the agriculturist the manorial system is of interest not from an economic standpoint only. Probably the earliest authentic account of a crude but definite rotation in the cultivation of land in Britain is instanced in the methods pursued in the cultivation of the manorial lands. The latter were divided into two parts, namely, a part cultivated for the immediate benefit of the lord of the manor, known as the *demesne*, and a part held from him in villeinage by subordinates of varying degrees. The bailiff, or representative of the lord, occupied the farmhouse, which usually stood a little apart from the row of dwellings occupied by the other cultivators. Without this village was the land under tillage, divided usually into three fields—one under oats, barley, or beans, one with wheat or rye, and one bare-fallowed. Each field was further parcelled out into portions of a size varying from half an acre upwards, and separated by balks or strips of unploughed land. Each member of this primitive agricultural community, according to his status, had a definite portion of each field assigned to him, which he was bound to cultivate according to the above rotation. This system of cultivation has been aptly termed the 'three-field' system, and the course of cropping pursued is practically identical with the old rotation of fallow, wheat, beans or oats which obtained until the introduction of clover and turnip husbandry. Beyond the cultivated portions lay the common pasture and the woods. The manor and its lands were not infrequently cut off entirely from the outside world by a waste of heath and swamp and forest land which entirely surrounded it and rendered it self-sufficing. Salt and iron were practically the only commodities which the manorial community required from without. The farming year began at Michaelmas, when wheat and rye were sown and the cattle brought in for the winter. Throughout the winter the villeins were occupied in threshing corn with the flail and winnowing it by hand. In spring the second arable field was prepared and the oats or barley seeded. Then followed a variety of miscellaneous duties, such as cleaning ditches, preparing wood for fencing off the crops against deer, &c. The main duty of the summer season lay in securing fodder and in fallowing the third field. [J. B.]

Manse.—Originally the word 'manse' in Scotland, as in the similar case of the word 'rectory' in England, referred to the portion of land, tithes, or offerings set aside for the maintenance of the incumbent of the parish. Gradually, however, the word has come to refer exclusively to the dwelling house provided for the incumbent.

In Scotland the minister of every landward parish, and of every parish which is partly landward and partly burghal, has a right to a manse, but ministers of burghal parishes are not entitled to claim one. It is the duty of the heritors of the parish to provide a competent manse for their minister, and thereafter 'to relieve him of all costs, charges and expenses for the repairing thereof, but declaring that manses being once built and repaired and the building and repairing satisfied and paid by the heritors, said manses are thereafter to be upholden by the incumbent ministers during their possession and by the heritors in time of vacancy'. After satisfactory repairs have been executed, the heritors are entitled to have the manse declared a free manse. Thereafter the obligation to maintain the manse involves on them liability for all extraordinary repairs necessitated by inevitable decay or unavoidable mishaps. Ordinary repairs must be executed by the incumbent.

The manse may be so dilapidated as to be beyond repair, in which case rebuilding will be necessary; and the rules upon which the Court will proceed have thus been summarized by Lord President Inglis: 'When the repairs required on a manse to make it sufficient are slight, and of the nature of proper repairs—that is, when they amount merely to restoration of the manse against wear and tear, there is no doubt that the Presbytery can go no further than merely to order such repairs, although it may be that the manse is not such as they would be authorized to order as a new manse if the old one had fallen into ruin; and on the other hand, when a manse is in such a state of decay that the repairs will amount very nearly to the cost of building a new manse, the Presbytery are entitled to order a new manse to be built. These are the two extreme cases, as to which there is no difficulty. But there is a variety of cases between these two extremes, and many such cases have come before the Court. It may not be possible to reconcile all these cases, but we must endeavour to extract from them some general rule. It appears to me that the cases in which the Presbytery may order additions to a manse which is clearly unsuitable in capacity and accommodation for the minister are those in which it has either become impossible to keep it up at all without structural alteration, or in which the extent and expense of the repairs, even assuming that they do not involve structural alteration, are very large, and approach to the cost of what is necessary to convert it by additions and alterations into a suitable residence.'

If the manse has to be rebuilt, it will not necessarily be sufficient to reinstate the old building. The standard of necessary comfort in the district and at the time will be taken into account, and the new manse may thus be built in a style considerably better than that which it replaces.

As already mentioned, the burden of repairing or rebuilding the manse falls only on owners, and the mode of ascertaining it is by a meeting of the heritors. The usual method of calling the meeting is by intimation by the minister after the forenoon service and by circular letter to the heritors, if not more than forty, giving them twenty-one days' notice. If the heritors number more than forty, then the meeting must be advertised in a county newspaper for two successive weeks. The Presbytery usually takes the initiative in the case of repairs and rebuilding. They visit the site, receive reports from skilled men, and order the necessary work. After it is completed they prepare a scheme of allocation of the expense, and decern for payment, their decree being put into execution where necessary by interposition of the Court of Session.

In the event of a heritor being dissatisfied with the proposed alterations or repairs, he has the right to appeal to the Sheriff of the county, which stops all further procedure in the Presbytery. From the Sheriff there is a further appeal to the Lord Ordinary on Teinds, whose judgment is final. During the progress of the rebuilding or repairing operations the minister is, if excluded from the manse, entitled to an allowance from the heritors in name of manse rent, the amount being determined by the Sheriff in case of dispute.

The minister cannot be compelled either by the Sheriff or the Presbytery to reside in the manse, and it has been decided that he has a right to let it. Whether he is entitled to virtually alienate the manse during his incumbency or let it for a prolonged term to his own exclusion, is a question the answer to which will vary according to the circumstances of each particular case. The minister is not liable for the poor rate, but this is a privilege personal to him alone, and if therefore the manse were let to third parties they could not claim immunity. The exemption of manses from poor rate does not extend to the school rate. See also GLEBE.

[D. B.]

Manures, Analysis of.—The object of analysing a manure is to ascertain the total amount that may be present of all or any of the fertilizing materials nitrogen, potash, or phosphoric acid, and in the latter case to discover what proportion is soluble in certain solvents like water, 2-per-cent citric acid, &c. Any reliable analytical method could be used, and valid reasons quoted in favour of it; but the advantage of uniform methods is obvious where legislation is in force dealing with fertilizers, and where an analysis may form the basis of legal action. Official methods are therefore drawn up which, though not necessarily better than any others, are adopted by all analysts in the country. A collection of these official methods for European countries and for America will be found in Wiley's Agricultural Analysis, to which the reader is referred. In view of the international character of the fertilizer trade, the International Congress of Applied Chemistry drew up at its Berlin meeting in June, 1903, a list of methods for universal adoption, which were conformed to by the committee appointed by the Board of Agriculture in 1906 to draw up official methods for Great Britain.

The British official methods are as follows: The sample is to be taken *strictly in accordance with the Act*. Three days' notice must be given in writing to the seller, with particulars as to the place, day, and hour of sampling. If the seller does not attend, the sample must be taken in presence of a witness. Not less than two bags, if the consignment is less than a ton, with an additional bag for every additional ton, are to be emptied separately on a dry, clean floor, worked up with a spade, and a spadeful from each set aside. The separate spadefuls are then to be thoroughly mixed, any lumps broken down, and a 2-to-4-lb. sample taken. If the manure is sold in bulk a like number of portions are to be drawn and the same method followed; if it is bulky, like shoddy, &c., great care must be taken that all matted portions are torn asunder. If, however, all parties agree, the sample may be taken from the bags by means of a sampling tube not less than 24 in. long and 2 in. in diameter, but in this case double the number of packages must be sampled. The sample is then divided into three parts, put into clean vessels, which are then sealed, labelled, and initialed by the person taking the sample and by the seller; two of the parts are sent to the analyst, and the third to the seller. The analyst must thoroughly mix the sample, and, if possible, pass it through a 1-mm. sieve. The percentage of moisture is determined by drying a weighed sample at 100° C.

NITROGEN, (a) *in Absence of Nitrates and Ammonium Salts.*—A weighed quantity of the sample is put into a Kjeldahl flask with 10 grm. of potassium sulphate and 25 c.c. of concentrated sulphuric acid; the flask is heated till the contents become colourless or of a light-straw colour. The operation may be accelerated by adding a small crystal of copper sulphate or a globule of mercury to the liquid in the digestion flask. During the process the nitrogen compounds are converted into ammonia, the amount of which is determined by distillation into standard acid after liberation with alkali, and, where mercury has been used, with the addition also of sodium or potassium sulphide solution. A blank experiment, using 1 grm. of pure sugar in place of the sample, is made in order to give the amount of nitrogen present as impurity in the reagents used, which amount must be deducted from the quantity found in the first experiment.

(b) *In Presence of Nitrates.* — A weighed sample is put into the Kjeldahl flask with 30 c.c. of concentrated sulphuric acid, 1 grm. of salicylic acid is added, and the flask shaken at intervals, but kept cool; then 5 grm. of sodium thiosulphate and 10 grm. of potassium sulphate are put in, and the flask heated till the contents are colour-

less or nearly so. The rest of the procedure is as before.

(c) *Nitrogen as Ammonia.* — Alkali is added, and the ammonia is distilled into standard acid as above.

(d) *Nitrogen as Nitrates, Ammonia and Organic Nitrogen being absent.*—1 grm. of the sample is placed in a 500 c.c. Erlenmeyer flask with 50 c.c. of water. 10 grm. of reduced iron and 20 c.c. of sulphuric acid of 1·35 sp. gr. are added. The flask is closed with a rubber stopper pierced with a thistle tube the head of which is half-filled with glass beads. The liquid is boiled for five minutes and the flask is then removed from the flame, any liquid that may have accumulated among the beads being rinsed back into the flask with water. The solution is boiled for three minutes more, and the beads again washed with a little water. The ammonia is then distilled off and estimated as before.

PHOSPHATES, (a) *Soluble in Water.*—20 grm. of the sample are continuously shaken for thirty minutes in a litre flask with 800 c.c. of water. The flask is then filled to the mark, again shaken, and the contents filtered. 50 c.c. of the filtrate are boiled with 20 c.c. of concentrated nitric acid, and the phosphoric acid determined by the molybdate method below.

(b) *Soluble in 2-per-cent Citric Acid Solution.*—5 grm. of the sample are put into a stoppered bottle of about 1 litre capacity, and 500 c.c. of a solution of citric acid, containing 10 grm. of the crystallized acid, added. The bottle is shaken in a mechanical shaker for thirty minutes. The solution is then poured all at once on to a large folded filter, and the filtrate, if not clear, passed through the same paper again. 50 c.c. of the filtrate are then taken and treated as directed below.

(c) *Total Phosphoric Acid.* — The nitric acid solution of a weighed quantity of the sample, after destruction of the organic matter if necessary, and removal of the silica by suitable means, is treated as below.

(d) *The Molybdate Method.*—To the solution obtained in (*a*), (*b*), or (*c*), which should contain ·1 to ·2 grm. of P_2O_5, 100 to 150 c.c. of molybdic acid solution are added, the whole warmed to 70° C. in a water bath for 15 minutes, allowed to cool, and filtered. The precipitate is washed first by decantation and afterwards on the filter paper with 1 per cent nitric acid; the filtrate and washings are set aside and tested with more molybdic acid. The precipitate is dissolved in cold 2-per-cent ammonia solution, about 100 c.c. being used for the purpose. 15 to 20 c.c. of magnesia mixture are then added, drop by drop, with constant stirring. After standing two hours, with occasional stirring, the precipitate is filtered off, washed with 2-per-cent ammonia, dried, ignited, and weighed as magnesium pyrophosphate.

The Molybdic Acid Solution. — 125 grm. of molybdic acid and 100 c.c. of water are placed in a litre flask, and the acid dissolved by the addition, while shaking, of 300 c.c. of 8-per-cent ammonia. 400 grm. of ammonium nitrate are added, the solution is made up to the mark with water, and the whole added to 1 litre of nitric acid (sp. gr. 1·19). It is maintained at about 35° C. for twenty-four hours and then filtered.

Magnesia Mixture.—110 grm. of crystallized magnesium chloride and 140 grm. of ammonium chloride are dissolved in 1300 c.c. of water. 700 c.c. of 8-per-cent ammonia are added, and the whole allowed to stand for several days and filtered.

AMMONIA SOLUTIONS.—(1) *8-per-cent*—1 volume of ammonia solution of sp. gr. ·880 is mixed with 3 volumes of water and the solution adjusted by addition of more water or ammonia till the sp. gr. is ·967.

(2) *2-per-cent.* — 1 volume of 8-per-cent ammonia is mixed with 3 volumes of water.

POTASH, (a) *Muriate, free from Sulphate.*—A weighed quantity of the sample—5 grm. of a high-grade, 10 grm. of a low-grade muriate— is dissolved in water, and the solution, filtered if necessary, made up to 500 c.c. To 50 c.c. of this a few drops of hydrochloric acid and 10 to 20 c.c. of a solution of 10 grm. of platinic chloride in 100 c.c. water are added. Evaporate over the water bath to a syrup, treat with alcohol of sp. gr. ·864. Collect the precipitate on a weighed filter paper, wash with alcohol as above, dry at 100° C., and weigh.

(b) *Salts containing Sulphate.*—Boil a weighed quantity of the sample (5 to 10 grm.) with about 300 c.c. water and 20 c.c. hydrochloric acid in a 500-c.c. flask. Barium chloride is added drop by drop till precipitation of the sulphuric acid is complete. Any excess of barium chloride is then removed by careful addition of sulphuric acid. Cool, and make up to 500 c.c. A portion of the solution is filtered, the precipitate washed, and the potassium in 50 c.c. of the filtrate determined as above.

(c) *Guanos, Mixed Fertilizers, &c.*—10 grm. of the sample are gently ignited to destroy organic matter, heated for 10 minutes with 100 c.c. of concentrated hydrochloric acid, and finally boiled with about 300 c.c. water. Filter into a 500-c.c. flask, raise to the boiling-point, and add a slight excess of powdered barium hydrate. Cool, make up to 500 c.c., and filter. To 250 c.c. of the filtrate add ammonium hydrate and ammonium carbonate, and then, while boiling, a little powdered ammonium oxalate. Cool, make up to 500 c.c., and filter. Evaporate 100 c.c. of the filtrate in a platinum dish, heat the residue first in an air bath and then very gently over a low flame till all volatile matter is driven off, but keep the temperature below dull redness. Dissolve in hot water, filter and wash, determine the potash in the filtrate as above. [E. J. R.]

Manures, Bacteriology of.—In this article it is proposed to indicate briefly the changes that take place in artificial manures through the vital activity of bacteria. The bacterial changes that take place in such manures are largely governed by such factors as drainage, tillage, liming, cropping, soil bacteria, &c., and are therefore more conveniently considered under the heading SOILS, BACTERIOLOGY OF. But the bacteriology of farmyard manure being more or less independent of such factors will therefore be more fully considered here.

When crops such as mustard or tares are ploughed into the soil as green manure, their nitrogenous and mineral constituents are and only can be made available as plant food by passing through a series of fermentations induced by putrefactive and other bacteria present in the soil. As in the case of farmyard manure, nitrates are ultimately formed, and much of the organic carbonaceous matter is transformed into humus. In the same way, all other forms of organic manure, as fish refuse, seaweed, dried blood, oilcake, &c., are alike useless to crops until their complex chemical molecules are broken down under the action of various bacterial ferments. In these cases the manure is applied in a more or less fresh condition, and the fermentation begins and ends in the soil. In the case of guano, however, the commercial powder applied to the soil is already fermented. It is, in fact, a product resulting from the bacterial fermentation of dung derived from sea birds, and contains nitrogenous and phosphatic compounds either already available or almost immediately available by simple fermentations, only taking perhaps a few days to accomplish. The nitrogen may be in the form of an ammonium salt, or of uric acid, or of guanine—bodies which are very readily nitrified in a warm moist soil containing a suitable basic substance.

With regard to the use of sulphate of ammonia as a manure, some crops appear to be able to use it directly as a source of nitrogen, while others show a decided preference for nitrates. In any case, however, when sulphate of ammonia is applied to normal well-tilled soil it is certainly nitrified, the rapidity of the action depending upon warmth, moisture, and the presence of air and lime.

The usefulness of calcium cyanamide as a plant food depends to a large extent upon the fermentative activity of bacteria. When freshly applied to the soil it is not only useless, but apparently to some extent harmful, as better results it seems are obtained when sufficient time is allowed—after application and before planting—for the chemical and bacterial changes to take place. Mixed with the damp earth the cyanamide enters into chemical relations with water and breaks up into carbonate of lime and ammonia. The ammonia is then readily nitrified through the activity of nitrifying soil bacteria. For further details see SOILS, BACTERIOLOGY OF.

FARMYARD MANURE. — The fermentative changes that take place during the 'ripening' of farmyard manure are due to the vital activities of certain micro-organisms, especially bacteria. The necessity for these changes lies in the fact that the relatively complex and to a great extent insoluble substances present in fresh dung are useless to crops as food. Before they can become available to roots they must be reduced to simpler compounds by a process of bacterial digestion. The three constituents of farmyard manure—urine, solid excreta, and straw—have each a characteristic fermentation, the exact nature of which depends to a large extent, however, upon the conditions under which the fermentation takes place. With respect to urine, its most valuable ingredient is urea, a nitrogenous compound whose chemical formula is $CO<^{NH_2}_{NH_2}$. This substance, under favourable conditions, is quickly fermented by quite a number of widely distributed bacteria that secrete a special enzyme (urease), by means of which they chemically break up the urea molecule by the introduction of two molecules of water, and produce therefrom carbon-dioxide gas and ammonia. This fermentative decomposition is instantly followed by a direct chemical combination of the carbon dioxide, ammonia, and water, resulting in the formation of ammonium carbonate. This process of ammonification takes place in presence of air, and is completed in two or three days if the temperature is high enough (about 30° C. appears to be the best).

The solid excreta of the manure represents, of course, so much of the food constituents as escape digestion and absorption in its passage along the alimentary canal. As a medium for bacterial fermentation its nature is determined by the composition of the ingested food and the character and condition of the animal using such food. In the excreta of herbivora there is a large percentage of 'cellulose' and woody fibre, but relatively little nitrogen-containing compounds if the digestion is normal. The bacterial fermentation of the solid excreta really begins in the alimentary canal. There are, in fact, two kinds of fermentation along the digestive tract—first, ordinary digestive fermentation, carried on in the stomach and small intestines, and brought about by the action of enzymes secreted by the various glands; and second, bacterial fermentation, mainly confined to the large intestines. The acidity of the gastric juice prevents to a large extent any bacterial action in the stomach; but after entering the small intestine the acidity of the food is partially neutralized by the alkaline bile and pancreatic juice, and in this still slightly acid medium lactic-acid-forming bacteria can seemingly grow and multiply, while the presence of the lactic acid holds the putrefactive bacteria in check. As the food goes farther and farther along the small intestines the amount of soluble organic matter gets less and less, and owing to the inflow of alkaline intestinal secretions the mass becomes nearer and nearer to being neutral. When the insoluble food residues enter the large intestine, bacterial changes at once set in. The proteids and bile constituents are attacked by putrefactive bacteria, and fermentation rapidly proceeds under the favouring conditions of a blood-heat temperature. The insoluble proteids are attacked, peptonized, and partially broken down to simpler compounds, some of which, although produced in extremely small quantities, are volatile, and give to the excreta its characteristic smell. In herbivorous animals the contents of the large intestine mainly consist of 'cellulose' and its modifications—wood and cuticular material or cork. The 'cellulose' is vigorously attacked by certain bacteria that, favoured by the absence of air, often succeed in fermenting a considerable portion of it into

marsh gas (CH_4) and volatile fatty acids such as butyric, acetic, &c. It is the accumulation of this marsh gas that, to a large extent at all events, gives rise to the 'wind' so freely evacuated by herbivorous animals, the horse for example. When the excreta is eventually expelled it contains a very large number of bacteria—from ten to fifty millions or more per dry gram—and has already undergone, as we have just seen, a certain amount of anaerobic fermentation at blood-heat temperature. Among the representative kinds of bacteria present are those capable of bringing about ammoniacal, denitrifying, and cellulose fermentation.

The straw commonly used as bedding consists mainly of carbohydrates, of which 'cellulose' and its modifications form the main bulk. There is comparatively little protein. Its natural bacterial flora includes denitrifying forms.

Fresh farmyard manure, then, is made up of a most complex mass of fermentable organic compounds already stocked with a teeming population of heterogeneous races of bacteria. The admixture of dung and litter is saturated with urine, a liquid containing a soluble, and therefore rapidly fermentable, nitrogenous compound (the urea), as well as soluble salts (phosphates, &c.), particularly favourable to the development of micro-organisms. The manure at this stage is useless to crops, as it consists almost entirely of insoluble organic substances, or, if soluble, still unsuitable, if not actually harmful, to living roots. Before it can become available and helpful to plants, the manure must undergo a process of further fermentation or ripening whereby the mass as a whole will become mild or humified and the unwholesome soluble organic matter replaced by simpler soluble compounds, such as nitrates, phosphates, salts of potash, &c., substances that are of direct use to plants as food. The most abundant, and therefore the most valuable, source of nitrogen in the heap is the urea of the urine. We have already seen how rapidly the urea becomes ammonified, and can appreciate the extreme difficulty of preventing its loss. The difficulty is all the greater because the ammonification of the albuminous substances in the solid constituents takes a much longer time, and while waiting for the completion of the slower fermentation the urea ammonia is very liable to evade retention and to escape as a volatile compound into the air, or to run off as a soluble compound in the drainage, or to be actually destroyed through the action of denitrifying bacteria if it remained in the fermenting heap. As most of the ammonia of manure fermentation comes from the urine, the early conservation of the carbonate of ammonia in the heap is therefore one of the practical problems of farming. Certain materials are often used to act as traps for the retention of the valuable nitrogen, such as peat, kainit, acid phosphate, sulphuric acid, &c. The peat acts as an absorbent, the acids by uniting with the ammonia form compounds less easily lost than the carbonate, while kainit inhibits or checks bacterial action. In using these materials it is well to remember that acidity also checks bacterial activity, and that even in the relatively low acidity of peat, ammonification is much slower than in a neutral medium, while it may be stopped altogether by spraying with sulphuric acid.

The slower fermentation of the dung and litter consists principally of the decomposition of albuminoids by bacteria of the putrefactive type, and of the fermentation of carbohydrates (cellulose, &c.) and of organic acids and their salts by other races of micro-organisms. As to the albuminoids, these through bacterial action are first of all hydrolysed and converted into a soluble form (peptone), after which they are split up into amides (or ammonium compounds) of the fatty acid series. The exact line of fermentative change will depend, however, upon the character of the bacteria producing the change, and this in its turn will depend upon whether the process is carried out in the presence of air or in its absence. Under the influence of oxygen, aerobic bacteria and moulds (*Mucors*) start a fermentation the final products of which will mainly be carbon dioxide, water, and ammonia. Under anaerobic conditions the end products of the complete fermentation will be marsh gas, sulphuretted hydrogen, free hydrogen, and ammonia (or free nitrogen, according to circumstances). The fermentation of the cellulose, begun in the large intestines, is continued in the manure heap. In the parts to which air has access the changes are due to the combined action of moulds and aerobic bacteria, and the character of the change is that of ordinary decay, ending by the oxidation of the carbohydrates into carbon dioxide and water, with the evolution of much heat. In the deeper layers, where the fermentation is carried on by anaerobic bacteria, the nature of the fermentation is entirely different. It is much slower in action, and is accompanied by much less heat. A preliminary change may be brought about through the action of a bacterial digestive enzyme (cytase) that acts upon some forms of the 'cellulose' group much in the same way as pepsin acts on albumin—that is, it renders it soluble. The final biological change, however, results in the liberation of carbon dioxide and of either marsh gas or hydrogen, leaving behind a dark-coloured mixture of substances largely made up of organic acids to which the name of *humus* is given. This humus also contains partially fermented insoluble nitrogen compounds, to which indeed the value of humus as a food reserve is due. Some of this humus may be lost by becoming dissolved in the alkaline carbonates of the urea fermentation and then escaping as drainage from the heap. It is clear, then, that during the course of fermentation soluble organic matter is first formed and then destroyed, until if continued long enough the soluble organic matter will practically disappear altogether. This will take place much sooner in presence of air than under anaerobic conditions. On the removal of the soluble organic matter (and not until then) nitrification sets in. This is a bacteriological fermentation by which ammonia gets converted first into a nitrite and then into a nitrate. There are two distinct kinds of organism concerned, and as the process

is essentially one of oxidation the presence of air is absolutely essential. This nitrate represents the final goal of the fermentation of nitrogen-containing compounds. But in manure undergoing the earlier stages of fermentation and still containing soluble organic matter, there are in its vast bacterial flora a very large number of organisms of the denitrifying type (see DENITRIFICATION IN SOILS). These in the absence of air can extract the oxygen from the nitrate molecule and use it for the destruction of the soluble organic matter. Nitrates we know are very soluble in water, and should they be carried to parts of the heap free from air and still containing soluble organic matter, they are certain to be destroyed. In this way the most valuable product of manurial fermentation may be lost.

A heap of fermenting farmyard manure is therefore the centre of an ever-varying series of complex vital activities carried on by different physiological races of germs that in turn flourish and decline as each successive type of fermentation waxes and wanes throughout the progressive stages of ripening. The farmer's ideal of a perfect ripening would seem to be one in which all the easily decomposable fermentable material has been destroyed without losing any of the nitrogen, phosphoric acid, or potash naturally contained in it. But we have seen how apparently impossible it is in ordinary farm practice to get anywhere near the realization of this ideal. Every step in the progress of ripening is accompanied by serious risks of nitrogen waste. Knowing the risks and the cause of such waste, and by exercising intelligent care and making use of conservation material, such as peat or fine soil, something at least may be done to preserve this valuable constituent during the critical period of general ripening. Or another course may be adopted, having for its aim the prevention, as far as possible, of ammonification on the one hand, or of the volatilization of such ammonia compounds as may be produced, on the other. This can be effected by keeping the manure in a compact mass, so as to exclude air as much as possible, and thus prevent the relatively rapid type of fermentation that is associated with the activities of aerobic bacteria. Furthermore, the volatilization of ammonia may be kept in check by the use of such substances as superphosphates, &c., as have been already referred to. As a further safeguard in the case of horse dung, in which denitrifying bacteria are especially abundant, sprinklings of kainit will tend to keep in check these nitrate-destroying organisms. In other words, this latter plan has for its object the delaying of the fermentation until after the manure is safely incorporated in the soil. The first method of complete ripening in the heap should commend itself to gardeners, who have to deal with relatively small areas, and with plants many of which are extremely sensitive in the matter of soil solutions. The second method means, of course, a less immediately effective manure, and the dosing of the soil with a rich flora of denitrifying germs; but it is an alternative that commends itself to many successful farmers. [D. H.]

Manures, Classification of. — In former times manures practically consisted of farmyard manure, derived from the excrements and litter of animals, and lime. A few other waste materials were used to a limited extent, but practically there were only two classes of manures, dung and lime. With the growth of our knowledge of chemistry and plant physiology a great many substances have come into use as manures, and the classification of manures is now complex.

Manures are classified according to the constituents which they supply to the soil for the use of plants. They may be divided first of all into general manures, and particular or special manures. General manures, of which farmyard manure is the great type, supply the soil with all the constituents which plants require from it. Particular or special manures supply to the soil only one or two of the special constituents which plants require. Lime is a manure of this type.

Plants require from the soil about a dozen different chemical elements. In manuring, however, we do not specially need to consider all of these. For instance, though iron is an element essential to plants, it is required by them in only very small quantity, and all ordinary soils contain it in quantities far greater than those demanded by our crops. We never, therefore, trouble about the supply of iron compounds in our manures.

In practice the elements the supply of which we have to consider in manuring are nitrogen, phosphorus, potassium, and calcium. The supply of sulphur, magnesium, and sodium have also to be considered in a few special cases. General manures like farmyard manure contain suitable compounds of all these elements. The special or particular manures are divided into nitrogenous manures which supply nitrogen; phosphatic manures which supply phosphorus; potassic manures which supply potassium; and calcareous manures which supply calcium.

GENERAL MANURES.— As has been already mentioned, farmyard manure is by far the most important of the general manures. It is itself composed of plant materials derived from the litter of animals and the waste of the food which they have eaten, and it therefore contains all the constituents of plants. Besides supplying the soil with all the chemical elements which plants require, it is useful in improving the mechanical condition of the soil. Other general manures are composts made from waste vegetable materials generally along with lime; seaweed, fowls' dung, preparations of human excrement, sewage sludges, green manures, and real guanos derived from the excrement and waste of sea birds. Some of these are not such well-balanced manures as farmyard manure, and are weak in certain constituents. Thus, seaweed contains very little phosphate, and guanos are generally poor in potash as compared with the phosphate and nitrogen which they contain.

NITROGENOUS MANURES. — There are three classes of these: nitrates, ammonia compounds, and nitrogenous organic manures. The chief nitrate is nitrate of soda. Nitrate of lime is also now upon the market, and will probably become

before long a manure of considerable importance. Sulphate of ammonia is practically the only ammonia compound which is used as a manure.

The nitrogenous organic manures are nearly all waste substances derived from animals. The chief are waste horn and hoof, shoddy and wool waste, hair, feathers, ground flesh, meat meal, dried blood, glue refuse, skin, and leather. Meat meal also contains more or less phosphate, and is therefore a phosphatic as well as a nitrogenous manure. In this class various kinds of refuse from oilseeds, such as rape dust and castor meal, are generally included. These also supply some phosphate, potash, and lime, and are really general manures particularly rich in nitrogen. See NITROGENOUS ORGANIC MANURES.

Along with the nitrogenous organic manures may be mentioned bones, which, though chiefly phosphatic, supply also a certain amount of nitrogen.

PHOSPHATIC MANURES.—These are divided into soluble phosphates, citric soluble phosphates, and insoluble phosphates. Until quite recently only two classes of phosphates were recognized in this country, namely, soluble phosphates, that is phosphates soluble in water, and insoluble phosphates. Citric soluble phosphates have obtained recognition only quite recently, and only to a very imperfect extent.

The chief soluble phosphate is superphosphate. Dissolved bones and dissolved guano also contain soluble phosphate together with citric soluble phosphates and insoluble phosphates. Superphosphate itself contains a little insoluble phosphate. Citric soluble phosphate is recognized practically only in the case of basic slag and the so-called basic superphosphate. Basic slag is by far the most important citric soluble phosphate.

The insoluble phosphates are of two kinds, bones and mineral phosphates. The chief bone phosphates are bone meal, bone dust, and steamed bone flour. As already mentioned, these manures also contain nitrogen. The mineral phosphates are of many different kinds, generally named according to the place of their origin, such as Florida phosphates, Algerian phosphates, Belgian phosphates, Carolina phosphates. They are also divided into pebble phosphates and hard rock, or into land and river phosphates, according to the conditions under which they are obtained. Coprolites, which were once so largely used but which have now almost entirely passed out of use, belong to the mineral phosphates.

The insoluble phosphates, whether bone or mineral, are to a certain extent soluble in a 2-per-cent solution of citric acid, though entirely insoluble in water. In fact the classification of phosphates is a very imperfect one, as the different classes overlap.

POTASSIC MANURES.—The chief potassic manures are kainit, muriate of potash, potash manure salt, and sulphate of potash. In all of these the potash is soluble in water. They are of three distinct types, however. Kainit is a raw salt which contains a comparatively small proportion of potash, and its action is modified by the large percentages of common salt and magnesium salts which it contains. Muriate of potash and potash manure salts are of the same class. The chief constituent of both is potassium chloride. But muriate of potash is the more highly purified compound, and contains a higher percentage of potash than the potash manure salts. Potash manure salt is frequently called sulphate of potash by dealers. This is quite wrong; it is a low-grade muriate of potash. Sulphate of potash, as the name implies, contains the potash in the form of sulphate. It is a refined salt, containing only a comparatively small proportion of impurities.

CALCAREOUS MANURES.—These supply lime either in the state of free or caustic lime, or in the state of carbonate of lime. The chief are lime shells, ground lime, hydrated lime, chalk, marl, ground limestone, and gas lime. Lime shells and ground lime are burnt lime in different states of fineness. Lime shells contain the lime in lumps, while ground lime contains it in a powder. Hydrated lime consists of lime which has been slaked and sifted. Chalk, marl, and ground limestone all contain lime in the mild form of carbonate of lime. Gas lime contains, in addition to some hydrate and carbonate of lime, compounds of lime with sulphur and other substances derived from coal-gas. The most distinctive of these compounds is the poisonous sulphide of lime, which is present in considerable proportion.

As a rule we consider only the main constituent of a special manure in classifying it. Thus nitrate of soda contains soda as well as nitrogen in the form of nitrate, and sulphate of ammonia contains sulphate as well as nitrogen in the form of ammonia, but both are classified and valued as nitrogenous manures only. Similarly, superphosphate and basic slag both contain lime, and superphosphate contains much sulphate, but both are classified and valued as phosphatic manures.

There are certain other classifications which are sometimes mentioned in dealing with manures. Thus they are sometimes divided into natural, and artificial or chemical manures. Farmyard manure and lime, for instance, are called natural manures, while nitrate of soda and superphosphate are called artificial or chemical manures. This classification is only a very loose and popular one, and it is difficult to carry it far. Lime is as much an artificial or chemical substance as nitrate of soda or mineral phosphate, while bone manures are sometimes placed in one class and sometimes in the other.

Mixed manures are commonly classified according to the crops to which they are intended to be applied. Thus we have turnip manures, grain manures, potato manures, &c.

Further information as to the different manures mentioned in this article will be found under their respective names. See also ARTIFICIAL MANURES. [J. H.]

Manures, Effect of on Soil.—A manure may act in at least three different ways on the soil; it may (1) react chemically with some soil constituent; (2) influence the physical properties of the soil; (3) modify the bacterial flora, and thus indirectly affect the changes going on in the soil.

1. Chemical Reactions with Soil Constituents.—(*a*) *The Calcium Carbonate.*—When sulphate of ammonia is added to soil it reacts with the calcium carbonate, forming calcium sulphate, which washes out in the drainage water, and ammonium carbonate, which eventually becomes nitrified. During nitrification a further amount of calcium carbonate is decomposed and converted into nitrate. These two changes together involve the decomposition of two molecular weights of calcium carbonate for every molecular weight of ammonium sulphate added, *i.e.* about 1½ cwt. of calcium carbonate for every 1 cwt. of ammonium sulphate. But the calcium nitrate is decomposed at the plant root and reconverted into calcium carbonate whilst the nitrate part enters the plant: the loss is therefore much less than these figures show; we shall see below that it is only one-half.

Table 1.—Calcium Carbonate in Broadbalk Wheat Soils, Top 9 inches.

No. of Plot.	Annual Manuring since 1856.	1865.		1881.		1893.		1904.		Annual Loss per acre
		Per cent.	Lb per acre.	Per cent.	Lb. per acre.	Per cent.	Lb. per acre.	Per cent.	Lb. per acre.	
3	Unmanured	4·54	113,500	3·97	99,200	3·45	86,200	3·29	82,200	800
10	400 lb. ammonium salts..	4·10	102,500	3·31	82,700	2·76	69,000	2·47	61,700	1045
11	400 lb. ammonium salts + super.	4·36	109,000	3·14	78,500	2·76	69,000	—	—	1429
5	Mineral manures only ..	4·96	124,000	3·75	93,700	3·34	83,500	2·94	73,500	878
6	Mineral manures + 200 lb. ammonium salts ...	—	—	3·41	85,200	1·98	49,500	2·33	58,200	1174
7	Mineral manures + 400 lb. ammonium salts ..	3·82	95,500	3·19	79,750	2·36	59,000	2·25	56,200	1010
8	Mineral manures + 600 lb. ammonium salts ...	—	—	2·84	71,000	1·73	43,200	1·76	44,000	1174
2*b*	Dung, 14 tons	4·20	105,000	3·79	94,700	3·46	86,500	3·28	82,000	590
9	Mineral manures + 275 lb. nitrate of soda ...	4·24	106,000	3·99	99,700	3·72	93,000	3·36	84,000	564

The actual amount of calcium carbonate removed from some of the Rothamsted plots receiving dressings of ammonium salts has been determined by Hall and Miller (Proc. Roy. Soc. 1905, vol. lxxvii, p. 1) by analysing samples which had been taken at different times. The unmanured plot is found to lose, as the result of weathering agencies, 800 lb. per annum in the top 9 in. The application of 400 lb. of ammonium salts raises the loss to 1045 lb. Again, comparing Plots 5, 6, 7, and 8, it is seen that ammonium salts increase the loss of calcium carbonate. By making similar determinations for the subsoil it is found that 200 lb. of the mixture of chloride and sulphate used on these plots causes the top 18 in. of soil to lose 120 lb. of calcium carbonate per annum, which is fairly near to the amount calculated (160 lb.) on the supposition that the whole of the ammonium salt reacts with the calcium carbonate to produce calcium sulphate and chloride. According to these results 1 cwt. of sulphate of ammonia will cause the removal of ¾ cwt. of calcium carbonate.

Although the loss of ¾ cwt. of calcium carbonate per acre is not usually a matter of importance, it may under certain circumstances lead to disastrous consequences. If sulphate of ammonia is applied very frequently to a soil initially poor in calcium carbonate, the whole of this substance may be removed, and certain other changes, due to micro-organisms, then set in, making the soil acid. Some of the plots at the Woburn experimental farm receive ammonium salts every year, and have for some time reached this acid state; barley is regularly sown, but practically none grows. Some of the Rothamsted grass plots have had all their calcium carbonate removed by large dressings of ammonium salts and have become acid; only three species of grass will grow on them. Similar instances are recorded from Rhode Island (see Expt. Station Record 1897, vol. viii, p. 571). It is wrong to call sulphate of ammonia an acid manure, as is sometimes done; it is a neutral substance, but it removes calcium carbonate, and then certain organisms can make the soil acid.

A comparison of Plots 10 and 11 in the above table shows that superphosphate also causes removal of calcium carbonate from the soil. This is due to a simple chemical reaction involving the production of dicalcium phosphate or tricalcium phosphate.

(*b*) *Oxides of Iron and* (*if present*) *Alumina.*—These may react with added phosphates to produce iron or aluminium phosphates. Warington discussed this action[1] in Journ. Chem. Soc. 1868, vol. xxi, p. 1, and Practice with Science, 1869, vol. ii.

(*c*) *Humus.*—Van Bemmelen (Land. Versuchsstat. 1888, 35, 69) has investigated the reaction between the added manures and humus, and finds that it is of exactly the same kind as that with clay. Ordinary humus contains bases which are replaced in equivalent amounts by the added base, and the results are of the same kind as those set out below.

(*d*) *Readily Decomposed Silicates, such as Zeolites.*—The silicates in the soil differ much in activity; some are very inert and decompose only with great difficulty, while others will readily enter into reaction with added salts.

[1] See also Gerlach, Landw. Versuchsstationen, 1895, vol. xlvi, p. 201; and art. Soils, Absorption of Salts by.

The change is of a very simple kind, being merely an interchange of bases; the added base (or part of it) becomes insoluble, whilst an equivalent amount of base from the silicate goes into solution. Thus, when sulphate of potash is added to the soil it reacts with the zeolitic silicates of lime, magnesia, soda, &c., forming soluble sulphates of lime, magnesia, soda, &c., and a rather insoluble complex silicate of potash, thus—

Complex silicate of LIME, &c. + Sulphate of POTASH =
(insoluble) (soluble)
Complex silicate of POTASH, &c. + Sulphate of LIME.
(rather insoluble) (soluble)

A very similar change takes place when sulphate of ammonia is added to soil; soluble sulphates of lime, magnesia, potash, &c., are formed, and the ammonia forms an insoluble compound and becomes 'fixed'. Sulphate of soda likewise causes the production of sulphates of lime, magnesia, and potash.

Both the 'fixing' of the added substance and the accompanying liberation of base from the silicates are of great practical importance. The added potash or ammonia is held in the surface in a state sufficiently soluble for plant nutrition, yet not soluble enough to suffer much loss by drainage. It will be observed that the 'fixing' is confined to the base; the acid part remains in solution in combination with lime, magnesia, &c., unless this combination happens to be insoluble, as, *e.g.*, the phosphate, in which case the acid also is fixed. But the sulphate, chloride, and nitrate are all soluble. Herein lies a great difference between nitrogen in the form of nitrate and nitrogen in the form of ammonia: in the latter case it occurs in the basic radicle, and therefore forms an insoluble silicate, so that it is not liable to be washed out of the soil; in the former case it occurs in the acid radicle, forming no insoluble compound in the soil, and therefore readily washes out.

The liberation of bases from the soil silicates explains why it is that substances like common salt, sulphate of soda, gypsum, and others, which are themselves of little or no nutritive value, may exert quite a considerable effect as manure. They convert some of the rather insoluble potash compounds into readily soluble forms easily taken up by the plant. They add nothing to the soil; there is no evidence to show that they even increase the amount of 'available' potash, *i.e.* that they decompose compounds which would not, in the ordinary course, have been utilized by the plant; what they do is to increase the rate at which the available potash can be used up.

It is to Way that we owe the first investigation of these facts. Soils had long been known to possess the power of withdrawing dissolved salts from water, but the action was regarded by Liebig (Natural Laws of Husbandry, p. 69) as purely physical, and analogous to the absorption of gases by charcoal. H. S. Thompson discovered certain facts inconsistent with this view, *e.g.* that calcium sulphate goes into solution when ammonium sulphate is added to soil (Journ. Royal Agric. Soc. 1850, vol. xi, p. 68). The full investigation was made by Way (*ibid.*, 1850, vol. xi, p. 323, and 1852, vol. xiii, p. 123), whose papers, especially the second one, must be ranked among the most important ever published in agricultural chemistry. He showed that the amount of base dissolved out is equivalent to the amount of ammonia fixed, and thus established the chemical nature of the change. His next experiments were to discover the particular constituent of the soil with which the reaction took place; he found it was neither the calcium carbonate, the sand, undecomposed rock even though finely ground, nor the organic matter. The active constituent was in the clay, but it formed only part of the clay, and moreover it lost its power on ignition. He found also that artificial simple silicates had no such power, but he prepared a number of double silicates, *e.g.* of lime and alumina, of soda and alumina, &c., which reacted, like clay, with ammonium salts to form an almost insoluble double ammonium silicate and a soluble calcium salt; and, also like clay, they lost this power after ignition. Although he did not establish the existence of such double silicates in soils, their behaviour was so like that of the reactive constituent in the soil that he considered himself justified in assuming their presence. Not long afterwards Eichhorn definitely showed that a natural aluminium and calcium silicate known as chabazite reacted with ammonium salts, and it is now generally recognized that a large class of naturally occurring silicates known as zeolites have this property (see SILICATES). Way's observations have been confirmed and extended by Voelcker (Journ. Roy. Agric. Soc. 1860, vol. xxi, p. 105, and 1864, vol. xxv, p. 333); van Bemmelen (as above quoted); and, more recently, by Hall and Gimingham (Trans. Chem. Soc. 1907, vol. xci, p. 677).

In 1865 Voelcker showed (Journ. Roy. Agric. Soc., New Series, vol. i, p. 298) that sodium salts liberate potash, lime, and magnesia from soils, and suggested that herein lay their value as manures. Of the numerous experiments made by later workers we need only refer to some by Passerini (Boll. Scuola Agrari di Scandicci, 1893, p. 78). 500-gram lots of soils were mixed with 20 grams of various salts and left in a moist state for three months; they were then extracted with 1 litre of boiling water and the soluble matter analysed. Salt and nitrate of soda were found to increase the amount of potash, lime, and magnesia dissolved; even dicalcic phosphate led to some increase in the potash. The actual weights of these three bases that were dissolved from the soils were as follows:—

	Soil alone.	Soil + 4 per cent Salt.	Soil + 4 per cent Nitrate of Soda.	Soil + 4 per cent Dicalcic Phosphate.	Soil + 4 per cent Tricalcic Phosphate.
Potash (K_2O) ...	·0067	·0792	·1500	·0193	·0118
Lime (CaO) ...	·0896	1·3745	1·3059	·2184	·1451
Magnesia (MgO) ...	·0063	·0423	·0302	trace	·0109

Numerous field experiments prove the same action. One of the Broadbalk wheat plots receives sodium sulphate, and another magnesium sulphate (with superphosphate and ammonium salts in each case); both substances are found to increase the supply of potash for the plan A number of analyses were published by Lawe and Gilbert in 1884 (Trans. Chem. Soc., vol. xl p. 305), from which Table 2 has been draw up.

TABLE 2.—EFFECT OF SODIUM AND MAGNESIUM SULPHATES IN INCREASING THE SUPPLY OF POTASH TO THE PLANT

	Ammonium Salts only.	Ammonium Salts + Super.	Ammonium Salts + Super + Sulphate of SODA.	Ammonium Salts + Super. + Sulphate of MAGNESIA	Ammonium Salts + Super. + Sulphate of POTASH.	Ammonium Salts + Supe + Sulphate of SODA, MAGNESIA, and POTASH
1852-1861.	Plot 10.	Plot 11	Plot 12.	Plot 14.	Plot 13.	Plot 7.
Potash in ash of straw, per cent	18·8	14·8	20·1	22·0	24·1	23·7
Potash in ash of grain, per cent	33·9	31·7	32·8	32·6	32·9	32·9
Weight of potash in ten whole crops, lb.	300	309	454	498	532	560
1862-1871.						
Potash in ash of straw, per cent	14·5	14·1	17·2	18·5	25·0	24·6
Potash in ash of grain, per cent . . .	34·1	32·1	33·3	33·1	33·5	33·4
Weight of potash in ten whole crops, lb.	240	260	378	391	552	530
Total amount of potash taken by crop during the twenty years, lb.	**540**	**569**	**832**	**889**	**1084**	**1090**

In the twenty years the sodium sulphate has enabled the plant to take up an additional 263 lb. of potash, whilst the magnesium sulphate has furnished it with an extra 330 lb. over and above what the crop on Plot 11 can get.

The Rothamsted soil is fairly well supplied with potash, which the sodium and magnesium sulphates have brought into solution. But where soils are poor in available potash it is not found that sodium salts are particularly effective. Experiments on this point have been made in Holland and are recorded in Bied. Centr. 1898, vol. xxvii, p. 227 (see also Journ. Chem. Soc. Abs. 1898, ii, p. 402).

Lime and chalk when applied to the soil are rapidly converted into calcium bicarbonate, whic then behaves like sodium and magnesium su phates in that it displaces potash from its i soluble combination. This is shown on t Rothamsted grass plots, where potash is foun to favour the growth of clover. On plots th have been well supplied with potash manu lime is found to increase the amount of clove but on plots which have received no potas lime is without effect, in spite of the enormo amount of potash in the soil. Lime can, in fac only hasten the rate of consumption of the avai able potash; it does not to any extent brea down the 'unavailable' compounds. The botan cal composition of the herbage for the thr years 1885–7 was as follows:—

		Clovers.		Grasses.		Weeds and Various.	
		Unlimed Plot	Limed Plot.	Unlimed Plot.	Limed Plot.	Unlimed Plot.	Limed Plot.
Potash manure supplied, in addition to superphosphate, and sulphates of soda and magnesia.	Plot 6 ...	11·7	20·1	72·8	67·7	15·5	12·2
	Plot 7 . .	22·0	41·8	64·3	48·4	13·7	9·8
	Plot 15 ...	3·2	35·3	67·4	53·8	29·4	10·9
No potash manure supplied, but only superphosphate, and sulphates of soda and magnesia.	Plot 8 ...	7·5	8·1	60·6	71·8	31·9	20·1

If the plant food rendered soluble by the lime is not taken up by the plant, it may be lost. Overliming has long been recognized as a pernicious practice, and common experience is embodied in the old saw:

> 'Lime and lime without manure
> Will make both land and farmer poor'.

Kellner has examined certain Japanese 'padd soils rendered infertile by overliming, and foun that much of the potash and nitrogen had bee washed away (Journ. Chem. Soc. Abstract 1892, Part II, p. 93).

Gypsum (calcium sulphate) may no doubt b have in the same way as the preceding salts.

is known to favour leguminous plants, and Boussingault (Economie Rurale, vol. ii, p. 49) found that it increased the percentage of potash in the ash of the clover plant, and also increased the total amount of potash taken up by the crop.

	Percentage of Potash in Clover Ash.		Weight of Potash taken up by the Crop, Kg. pro Ha.	
	No Gypsum supplied.	Gypsum supplied.	No Gypsum supplied.	Gypsum supplied.
1841 (good crop)	19·6	27·8	26·7	95·6
1842 (poor crop)	22·5	25·3	28·6	97·2

Gypsum has also been found by experiments similar to Passerini's, already quoted, to increase the solubility of the potash; at the same time it must be pointed out that gypsum does not on the Broadbalk plots increase the amount of potash available for the plant; Plot 11 (see Table 2) receives gypsum (which is present in superphosphate), while Plot 10 does not.

The composition of the drainage water from the Broadbalk wheat plots also confirms the facts set out above, and shows the increased loss of calcium sulphate when the sulphates of ammonia, soda, or potash are applied to the soil. Voelcker's analyses of five samples collected at different dates between 1866 and 1869 are given in Table 3 (Trans. Chem. Soc. 1871, vol. xxiv, p. 287).

TABLE 3.—COMPOSITION OF DRAINAGE WATER FROM BROADBALK WHEAT FIELD. PARTS PER MILLION.

Manuring.	Dung	No Manure.	Super. + Sulphates of Soda and Magnesia					400 lb. Ammonium Salts.				
			Alone.	+ Ammonium Salts			+ Nitrate of Soda, 550 lb	Alone.	+ Superphosphate.			
				200 lb	400 lb.	600 lb.			Alone.	+ Sulphate of Soda.	+ Sulphate of Potash.	+ Sulphate of Magnesia.
Plot No.	2	3 and 4	5	6	7	8	9	10	11	12	13	14
Lime	147·4	98·1	124·3	143·9	181·4	197·3	118·1	154·1	165·6	191·6	201·3	226·7
Magnesia	4·9	5·1	6·4	7·9	8·3	8·9	5·9	7·4	7·3	6·6	9·3	11·6
Potash	5·4	1·7	5·4	4·4	2·9	2·7	4·1	1·9	1·0	2·7	3·3	1·0
Soda	13·7	6·0	11·7	10·7	10·9	10·6	56·1	7·1	6·6	24·6	6·1	5·6
Ferric oxide	2·6	5·7	4·4	2·7	8·1	2·7	5·1	4·0	3·4	3·6	3·7	3·7
Chlorine	20·7	10·7	11·1	20·7	26·1	39·4	12·0	32·0	31·6	30·9	36·6	39·4
Sulphuric acid	106·1	24·7	66·3	73·3	90·1	89·7	41·0	44·4	54·3	96·7	86·9	99·7
Phosphoric acid	—	·6	·9	1·54	·9	·17	—	1·46	1·66	1·26	1·09	1·01
Soluble silica	35·7	10·9	15·4	24·7	17·0	20·9	10·6	13·7	11·3	17·9	28·3	14·0
Nitrogen as ammonia ...	·20	·14	·14	·24	·09	·33	·3	·1	·2	·36	·2	·1
Nitrogen as nitric acid ...	62·0	15·0	19·6	32·9	54·0	65·0	70·9	53·6	59·1	58·3	67·3	74·0
Organic matter, carbonic acid, and loss	77·3	67·7	60·4	84·6	92·6	110·7	99·7	87·1	83·9	96·4	100·1	121·8
Total solids ...	476·0	246·4	326·0	407·6	492·4	548·4	423·8	406·9	425·9	530·9	544·3	598·6

2. CHANGES IN THE PHYSICAL PROPERTIES OF THE SOIL.—The effect of lime and of organic matter is discussed under CALCIUM COMPOUNDS IN SOIL, HUMUS, and SOIL. It is only necessary now to add a few words on the effect of nitrate of soda. Practical men have long known that nitrate of soda has a bad effect on soils inclined to be sticky; the explanation is to be found in the decomposition that takes place at the plant roots. The acid radicle is taken up by the plant, but the base remains in the soil combined with carbonic acid to form a carbonate, which deflocculates clay (see CLAY). To a less extent potassium sulphate also injures the texture; it reacts somewhat with calcium carbonate to produce potassium carbonate, which is, like sodium carbonate, a powerful deflocculator. On the other hand, neither ammonium sulphate nor superphosphate produces any bad effect, since they do not give rise to alkaline carbonates; the ammonia is too quickly acted upon by the clay and by micro-organisms to cause any deflocculation.

3. CHANGES IN THE BACTERIAL FLORA (see FERTILITY). [E. J. R.]

Manure Shed.—The manure shed is the place for dealing with manufactured or extraneous manurial stuffs—artificial manures in short. These being in evidence for two or three months at most (in spring and early summer), the manure shed for the time being is usually a loose box, a turnip house, or a part of the cart shed, taken in hand for the purpose. This may do no harm either to the turnip house—

provided it is done with for the season—or to the cart shed, but a loose box that has recently done service as a manure shed is hardly a fit place for an animal out of sorts to recuperate. At the small farm the presence of a special place of the kind is more a luxury than a necessity; but at the homestead that serves a large holding a properly constructed manure shed cannot very well be dispensed with. Here it is not uncommon to find the farmer preparing mixtures after a formula of his own. This implies a roomy shed. Even when he is content to let the manure merchant do the mixing in accordance with the ideas of the 'trade', a good deal of space is needed in which to store the large amount of stuff he is obliged to purchase. Moreover the different fertilizing materials have mostly to be kept apart. In fact, the enterprising farmer of any large holding is handicapped to a considerable extent when he is without the use of a special shed for artificial manures. The shed should be of the dimensions as regards floor space in proportion to the size of the farm; at any rate in accordance with the high-farming proclivities of the tenant. It need not be high in the side wall—no higher than will allow a loaded cart to be passed in and out. It should be open to the roof, and be lighted and ventilated thereby. Opening roof lights are an advantage. A floor of concrete is clearly the most suitable. Although specially required for only a short portion of the year, the shed can be put to useful purpose during the remainder of the twelve months. It can, for instance, hold those implements that are in use when fertilizers are in evidence at the homestead. [R. H.]

Manures, Mixing of.—The artificial or chemical manures are not, as a rule, all-round manures suited to supply to the soil all the constituents required by crops. Generally speaking, they supply only one or two of the chief constituents required by crops. In order to make balanced manures suited to supply all the chief constituents which crops require, it is usual to make mixtures of artificial manures. It is only since artificial manures came into use that the mixing of manures became of importance.

Various chemical reactions occur when artificial manures are mixed together, and as some of these are harmful and cause either loss of valuable material through volatilisation or such alteration in the mixture as to render it less valuable through loss of solubility or loss of condition, it is important that farmers should know something of the advantages and disadvantages of certain mixtures. As a rule farmers have not sufficient knowledge of chemistry to reason out such questions from chemical principles, and even a chemist who has not actual experience of manures is apt to go astray if he trusts merely to theoretical knowledge.

Among the traditional and so-called natural manures we have an example of a mixture which should not be made. Dung should not be mixed with lime, or the lime will drive off the ammonia of the dung in the form of ammonia gas and so cause it to be lost.

In making mixtures of artificials, nitrogenous, phosphatic, and potassic manures are usually mixed together so as to make an all-roui manure. The chief nitrogenous concentrat manures are nitrate of soda and sulphate ammonia. Sulphate of ammonia may be qui safely mixed with acid phosphatic manures li superphosphate and dissolved bones. It m also be safely mixed with the neutral insolub phosphates which we have in bone meals a bone flour. But it must not be mixed with a manure which contains free lime, since free lir drives off ammonia as gas and causes loss of tl most expensive constituent. Sulphate of a monia must not therefore be mixed with ba slag. It is a quite common and a very wastef mistake for farmers to make this mixture. Th who have made it are not likely to do it aga as the ammonia gas given off is overpoweri and if the mixture be made in an enclosed pla may be very dangerous. Accidents have be caused by persons making such a mixture in closed shed and being overcome with the fum of ammonia. Manures which contain much ca bonate of lime, such as Belgian and Algeri phosphates, are also unsuitable for mixing wi sulphate of ammonia. In this case the loss ammonia is not so rapid as when a manure co taining free lime is used, but some loss is apt take place. Nitrate of soda, on the other han may safely be mixed with basic slag, and wi Belgian and Algerian phosphates, but shou not be mixed with acid manures like supe phosphate and dissolved bones. In this respe nitrate of soda and sulphate of ammonia a opposite in their nature. What the one cann be mixed with, the other may be safely mix with. When nitrate of soda is mixed with a acid manure, the acid combines with some of tl soda and liberates some nitric acid. This is a to be lost as vapour, especially if heating tak place. Another reason for avoiding a mixtu of superphosphate and nitrate of soda is th the mixture is apt to become soft and pasty.

Nitrate of soda in limited quantity can l safely mixed with superphosphate and oth acid phosphates if certain precautions are o served, and such mixtures are frequently mad The superphosphate must first be mixed with 'drying' agent like bone flour. This not onl dries the manure and makes it more powder but it prevents it acting readily on the nitra of soda. A mixture of superphosphate with a co siderable proportion of bone flour or fine bor meal may therefore be mixed with nitrate of sod in limited quantity if heating be prevented.

Dissolved phosphates, and also insoluble pho phates like basic slag, bone meal, steamed bon flour, and ground mineral phosphates, may safel be mixed with any of the potash manures. Whe acid phosphates, like superphosphate, are mixe with kainit, muriate of potash, or potash manu salt, a little acid fume may be given off; bu this is hydrochloric acid, and its loss does nc diminish the value of the manure in any way.

Dissolved phosphates, like superphosphat and dissolved bones, should not be mixed wit any manure containing free lime or carbonat of lime, or the soluble phosphate will be re verted to the insoluble form to an extent whic will depend on the amount of lime present

These manures, therefore, should not be mixed with basic slag, with ground mineral phosphates, or with bone ash. On the other hand, steamed bone flour and bone meal cause almost no reversion unless the mixture is allowed to lie for a long time, while they are quite effective as driers and produce a dry powdery mixture with the acid manure.

Mixtures of superphosphate with basic slag are often made because the mixture is fine and dry and sows much better than superphosphate alone and yet is not so dusty as slag, and also because it is supposed that by making this mixture the disadvantages of superphosphate due to its acidity are removed. A better mixture is obtained by using steamed bone flour instead of basic slag. All the advantages of the former mixture are obtained, without the disadvantage of rendering the soluble phosphate insoluble.

Mixtures such as those just mentioned are frequently made because they are convenient or suitable for sowing. Bone flour and slag are extremely dusty and unpleasant things to sow. They are therefore often mixed with moist or sticky manures to the improvement of both. Either slag or bone flour is suitable to mix with such manures as kainit, muriate of potash, and nitrate of soda, and, as already mentioned, superphosphate and bone flour when mixed improve one another. Dusty manures are also sometimes slightly damped, or are mixed with damp earth or damp peat dust, to make them less unpleasant to sow.

Organic manures like fish guano, Peruvian guano, and meat meal may be mixed with any other of the ordinary artificial manures. Such substances are often introduced into mixtures not only on account of their own manurial value, but in order to keep the mixtures friable and open in texture.

The following are examples of excellent all-round mixtures: (1) Sulphate of ammonia, superphosphate, steamed bone flour, fish guano, and potash manure salt; (2) nitrate of soda, basic slag, meat meal, kainit. In either of these, fish guano, Peruvian guano, and meat meals may be substituted for one another according to circumstances. Similarly, muriate of potash or sulphate of potash may be used instead of potash manure salt or kainit where circumstances render it advisable. The above mixtures are merely mentioned as examples, and might be greatly varied. The proportions in which the constituents are mixed could be varied very widely to suit different requirements.

Many mixtures of manures become hard or lumpy on standing. Mixtures with kainit are specially liable to do so, but nearly all mixtures undergo some chemical change on keeping and at the same time become more or less hard or lumpy. The farmer is therefore recommended to make his mixtures in comparatively small quantities for immediate use, and not to make up large quantities of mixtures and store them for a long time.

When manures are compounded they should be very thoroughly mixed. The better they are mixed the more even and thorough is their effect when incorporated with the soil. [J. H.]

Manures, Valuation of.—There are two points of view from which we can look at the value of manures—(1) as articles with a certain money value in the market, and (2) as articles with an agricultural value to the farmer for increasing his crops. The market value of a manure and what we may call its agricultural value do not necessarily correspond, they may bear little relation to one another; but they are apt to be confused, and confusion of thought and argument sometimes arises through failure to distinguish between them. The market value of a manure depends upon market conditions—on supply and demand. If the demand is great while the supply is small, whether naturally, or by artificial restriction of the output, or owing to the difficulty and expense of obtaining the article, the price will be high. While, conversely, if the supply is great and the demand small, the price will be low. These facts are constantly illustrated in the manure market. Thus, when the supplies of Peruvian guano fell off owing to the exhaustion of the deposits and the demand did not fall off in proportion, this guano became relatively to other manures very dear (see GUANOS). Quite recently the great demand for fish manures from Japan caused the demand to exceed the supply, and the price of this article rose to a prohibitive figure. When, before the formation of 'the nitrate combine', the various producers of nitrate of soda were competing with one another and flooding the market with this article, the price fell to such a figure that it was not profitable for certain of the producers to continue work. After the formation of the combine the output was restricted to the estimated demand, and the world's markets were manipulated and all competition in price prevented; the price in consequence steadily rose till it was more than 50 per cent higher than before the formation of the combine. Examples might be multiplied to show that the market values of manures fluctuate constantly with market conditions which may not in any way reflect agricultural requirements.

The agricultural value of a manure, on the other hand, is the real value of the manure to the farmer as an increaser of his crops in quantity and value. It cannot be expressed in terms of the money value of the manure, for that is the market value, which fluctuates with market conditions which it has been shown are often unrelated to the agricultural value. It can only be expressed relatively to other manures of a similar kind, or relatively to other manures used under a similar set of conditions. Thus, nitrate of soda and sulphate of ammonia are both nitrogenous manures valued for their nitrogen. In real agricultural value nitrogen in nitrate of soda is on the average for all crops and seasons a little more valuable than the same amount of nitrogen in sulphate of ammonia. The proportion is roughly as about 10 to 9.

While the market values of manures are often greatly influenced by conditions unrelated to their real agricultural values, in the long run the market values tend to arrange themselves approximately as the relative agricultural values. For when a manure becomes too dear, relatively

to others, many people cease to buy it. A good example of that took place recently when fish manures rose greatly in price and their use was given up for the time by many users in this country.

In the valuation of manures it is the money values, that is to say the fluctuating market values, and not the agricultural values, with which we deal. It is useless to compare the values per ton or per hundredweight of different manures unless we take into account the various proportions of valuable constituents which they contain. Manures are therefore valued by means of a unit system, which gives a true basis of comparison. The unit adopted for this purpose is 1 per cent in a ton, or 22·4 lb.

Thus sulphate of ammonia was recently quoted in the central manure markets at about £11 per ton, while nitrate of soda was quoted about £10, 10*s.* per ton. Here the sulphate of ammonia is a little dearer per ton than the nitrate of soda. Both manures are used on account of their nitrogen. From a manurial point of view that is their only valuable constituent. Sulphate of ammonia of ordinary commercial quality contains about 20 per cent of nitrogen, while ordinary commercial nitrate of soda contains only 15·5 per cent of nitrogen. We cannot therefore compare the prices at which nitrogen can be bought in these two forms by comparing prices per ton. In a ton of sulphate of ammonia there are 20 units of nitrogen, and in a ton of nitrate of soda there are 15·5 units of nitrogen. The unit price of nitrogen in sulphate of ammonia is therefore $\frac{£11}{20} = 11s.$ at the price quoted, and the unit price of nitrogen in nitrate of soda is $\frac{£10,\ 10s.}{15·5} = 13s.\ 6\frac{1}{2}d.$ per unit. When the market prices are as above nitrogen costs much more in the form of nitrate of soda than in the form of sulphate of ammonia. Sulphate of ammonia would require to cost £13, 11*s.* per ton before the nitrogen it contains would cost as much as that in nitrate of soda at £10, 10*s.* per ton.

The only constituents ordinarily valued in manures are nitrogen, phosphates, and potash. We can find what we may call standard unit prices for these if we calculate the unit prices in the cases of a number of standard articles from the market quotations of these articles. Such unit prices are, of course, subject to constant fluctuations with the fluctuations of the market.

Nitrate of soda and sulphate of ammonia are standard nitrogenous manures. They contain nitrogen in its most valuable and quick-acting forms as manure. Quotations of the market prices of these substances are always easily obtained. It is always easy, therefore, by calculations similar to those given above to obtain the unit prices at which nitrogen can be obtained in these manures. The figures so obtained are of the greatest value to the purchaser of manures, for they give him a unit price for nitrogen which should be his maximum unit price. As we have nitrogen in its most valuable forms in these manures, it is not good business for a buyer to pay more for it in other forms. Thus if he finds, for instance, that the nitrogen in dissolved bones or in fish guano costs him 15*s.* or 16*s.* per unit while he can buy it in sulphate of ammonia at 11*s.* per unit, he should cease to buy his nitrogen in the more expensive form, for agriculturally the nitrogen in fish guano or in dissolved bones is not more valuable than an equal amount of nitrogen in sulphate of ammonia, it is rather less valuable for most agricultural purposes.

In certain manures, such as ground horn, ground hoof, shoddy, &c., the nitrogen is of distinctly lower agricultural value than the nitrogen in sulphate of ammonia or nitrate of soda. Such manures should not be bought, therefore, unless the unit of nitrogen costs distinctly less than in the cheaper of the two standard manures, nitrate of soda and sulphate of ammonia.

In the case of phosphates there are manures of three distinct grades of agricultural availability. The highest availability is represented by water-soluble phosphates such as superphosphate, the next grade by the phosphates in such manures as basic slag and steamed bone flour, and the lowest availability by such a manure as ground mineral phosphate. We can calculate the unit value of these three classes of phosphates from such standard substances as superphosphate, basic slag, and ground Algerian phosphate respectively.

If a superphosphate containing 32 per cent of soluble phosphate costs £3 per ton, soluble phosphate costs $\frac{£3}{32} = 1s.\ 10\frac{1}{2}d.$ per unit. Similarly if basic slag containing 40 per cent of phosphate costs £2, 10*s.* per ton, the phosphate in basic slag costs $\frac{£2,\ 10s.}{40} = 1s.\ 3d.$ per unit. While if ground Algerian phosphate containing 60 per cent of phosphate costs £2, 10*s.* per ton, the phosphate in this form costs $\frac{£2,\ 10s.}{60} = 10d.$ per unit. In this way we find prices at which a unit of phosphate in these different forms can be purchased in the market. The farmer can take these as standards, and can judge by comparing with these whether any phosphatic manure which he is offered is of good value or not.

Thus, dissolved bone is a dear manure because the soluble phosphate which it contains costs more per unit than the soluble phosphate in mineral superphosphate, and the insoluble phosphate which it contains more than the insoluble phosphate in bone flour, or bone meal, or basic slag; while in availability and real value to the farmer they are no more valuable or available than the soluble phosphate of superphosphate or the insoluble phosphate of steamed bone flour or basic slag.

Again, if a basic slag containing 30 per cent of phosphate is offered at £2 per ton, it is dear as compared with one containing 40 per cent at £2, 10*s.* per ton. In the latter the phosphate costs, as shown above, 1*s.* 3*d.* per unit. 30 × 1*s.* 3*d.* = 37*s.* 6*d.* Therefore in order to purchase the 30-per-cent slag at the same rate as the 40-per-cent slag, it should cost only 37*s.* 6*d.* per ton. At £2 per ton it costs 1*s.* 4*d.* per unit

In the case of potash manures the unit prices of potash can be similarly found. Thus muriate of potash containing 50 per cent of potash at £8, 15*s*. per ton costs $\frac{£8, 15s.}{50} = 3s.\ 6d.$ per unit of potash; while potash salt containing 30 per cent of potash at £4, 15*s*. per ton costs $\frac{£4, 15s.}{30} = 3s.\ 2d.$ per unit: and kainit containing 12½ per cent of potash at £2, 5*s*. per ton costs just over 3*s*. 7*d*. per unit. At these prices kainit, though much the cheapest per ton, is dearest per unit of potash.

While it is easy to calculate the unit prices of simple manures such as those dealt with above, which contain only one manurial constituent of value, and to value these by the unit, the question becomes more complicated when we deal with manures containing more than one constituent of value, and especially when we have to deal with mixed manures which may be compounded of a great many different ingredients. If, however, the unit prices of the leading simple manures are determined, these are a great help and guide in the valuation of all kinds of compounds and mixtures. Every purchaser of manures should become accustomed to deal with their values per unit and not merely per ton. If manure consumers generally could compare manure prices per unit, the differences between real agricultural values and market values would much more quickly adjust themselves, for people would not so readily pay excessive prices for any article whose market value either from natural or artificial causes had risen, while they could buy an article equally useful for their purpose at a lower unit price.

In the case of mixed or compounded manures the unit prices derived from simple articles can be used to calculate whether the price charged is in excess of that at which an equally good manure could be made up from simple materials. Thus, if nitrogen in so valuable a form as sulphate of ammonia can be purchased at 12*s*. per unit, while soluble phosphate in superphosphate can be purchased at 1*s*. 11*d*. per unit, insoluble phosphate in bone flour at 1*s*. 2*d*. a unit, and potash in potash salts at 3*s*. 2*d*. per unit, these units can be applied to value any mixed manure, for it is not economical to pay more for a mixed manure when one can be made up from such valuable materials at these unit prices. In order to value a mixed manure as suggested above, the number of units of each constituent is multiplied by the unit price, and the results added together. By way of example, suppose a grain manure contains—

Nitrogen	7	per cent
Soluble phosphate	12	„
Insoluble phosphate	4	„
Potash	5	„

We may value it as follows:—

	s.	*d.*
Nitrogen, 7 units at 12*s*. .. ... =	84	0
Soluble phosphate, 12 units at 1*s*. 11*d*. =	23	0
Insoluble phosphate, 4 units at 1*s*. 2*d*. =	4	8
Potash, 5 units at 3*s*. 2*d*. ... ... =	15	10
Total ...	127	6

To this must be added something for the labour of making up, storing, pulverizing, &c., the manure mixture. This is frequently estimated at 7*s*. 6*d*. per ton. Adding this, the valuation comes to 135*s*. = £6, 15*s*. per ton.

A purchaser who knows how to deal with manures should not pay more than this price, for if more is asked he can have made up to his own order a mixture from such ingredients as sulphate of ammonia, superphosphate, bone flour, and potash salt which will be of at least as good quality as that offered, and will be cheaper. Such units as those mentioned above are only applicable to high-quality mixtures; if low-grade mixed manures are valued by these units they will be overvalued. For instance, if the nitrogen is derived from shoddy, and still more if it is derived from ground leather, it is not worth 12*s*. per unit.

A scale which gives the unit prices of the leading manures at any given time is a most useful guide to all farmers who understand how to deal with manure values in terms of units. Such a scale is issued each year by the Highland and Agricultural Society of Scotland at the beginning of each manure season for the use of its members. Such scales should be in universal use among farmers.

It is to be remembered that such a scale applies only to certain central manure markets. Geographical position affects the cost of manures. The more remote any place is from a central manure market, or from the point of production, the greater will be, generally speaking, the cost of manures, on account of the added cost of carriage and handling. To make use in a country district of a unit scale, which is based on central market prices, the cost of carriage from the centre to the district must be added.

Farmers are also apt to forget sometimes that cash and credit prices are quite different things. Valuations made by a unit scale give cash prices, which are lower than credit prices. [J. H.]

Manurial Values of Foods. See art. Compensation for Unexhausted Improvements.

Manuring, Principles of.—A manure is a substance which increases the fertility of the soil and causes it to grow larger crops. It is only since the beginning of the 19th century that any accurate knowledge has been obtained of the functions of manures and the principles of manuring. In its origin to manure meant to work the soil by hand, and hence 'to till'. An early belief was that manures helped to pulverize and till the soil, and that their use to the farmer was as an instrument of tillage. Our modern knowledge teaches us that while manures have much wider uses, there is a certain germ of truth in this idea.

During the 19th century various theories as to the action of manures were put forward from time to time, and gradually by continuous experiment our knowledge of the action of manures and of the means by which they increase the fertility of the soil was built up. Manures improve the soil in two main directions: (1) by adding to it substances which plants take up from it by their roots; and (2) by improving its

mechanical condition so as to make it a more kindly and suitable medium for the growth of crops.

Plants require from the soil a variety of different substances, which are sometimes spoken of as 'plant foods'. These really form the crude constituents from which the plant elaborates its true food. The plant is built up mainly of compounds of carbon, hydrogen, oxygen, and nitrogen, and contains in addition smaller proportions of compounds of phosphorus, sulphur, chlorine, potassium, calcium, magnesium, and iron. Compounds of certain other elements are generally present also, but all those mentioned above are not only always present in plants but are all essential to plant life. Of these elements the carbon is obtained from the atmosphere through the leaf, all the others are obtained from the soil through the root. If a soil is unable to supply any one of these elements of crude plant food in a state fit for assimilation by the root, that soil will be infertile. It is not sufficient that the soil should contain these different elements; in order that it may be fertile it must contain them in a state available to plants and suitable for assimilation by plants. Thus, a soil might contain many tons of potassium per acre locked up in the form of insoluble silicates and yet be infertile for want of compounds of potassium available to plants; or again, it might contain sulphur in the form of sulphides, not only useless but actually poisonous to plants, which require their sulphur in the form of sulphates.

The most important of the substances taken by the plant from the soil, and the one taken in by far the greatest quantity, is water. In this form the plant takes up most of its hydrogen and oxygen. Watering or irrigating the soil is therefore an act of the same nature as adding dung or superphosphate, and might in a strict sense be looked upon as manuring.

Plants take up nitrogen from the soil in various forms, such as nitrates and ammonium compounds; and nitrogenous substances which are capable of yielding nitrates by decomposition and nitrification are suitable for use as manures to supply nitrogen.

Phosphorus, sulphur, and chlorine should be supplied in the forms of phosphates, sulphates, and chlorides respectively, as these are forms suitable for assimilation by plants. The metallic elements potassium, calcium, magnesium, and iron should be supplied in the form of salts soluble in water, or in very weak acids, such as the carbonic acid solution naturally present in the soil.

In manuring, it is not necessary to consider the supply of all the substances which plants require from the soil. For instance, plants require only very small quantities of iron, and the soil always contains comparatively large quantities in a sufficiently available condition. So also, except in special circumstances, it is not necessary to consider the supply of magnesium, chlorine, or sulphur. The constituents which it is specially necessary to consider the supply of in dealing with manures are nitrogen, phosphates, lime, and potash.

The soil undergoes loss of valuable constituents—(1) by the removal of crops; (2) by drainage; (3) by decay and the escape of materials in the form of gas. At the same time it gains in fertility—(1) by the weathering of rock materials which it contains; (2) by the fixation of atmospheric nitrogen by various organisms, such as those which work in symbiosis with leguminous plants; (3) by the small quantities of valuable materials, such as ammonia and nitrates, brought down by the rain from the atmosphere, or directly absorbed by the soil itself from the atmosphere, as well as (4) by the addition of manures. The removal of crops is not the only drain on the fertility of the soil, on the one hand, nor is the addition of manures the only source from which it gains elements of fertility on the other.

In a state of nature the soil as a rule does not lose in fertility. In many cases if a soil be allowed to run wild it gains in fertility. Though no manures are applied, nothing is removed in the form of crops. The plants which grow naturally on the soil die where they grew and, by decay, return their constituents to the soil, or, if they are eaten by wild animals, these deposit their droppings on the soil in return. Under such conditions the gains in fertility often more than counterbalance the losses. On the other hand, when agriculture is carried on, when the soil is drained and tilled, and when the crops are removed from the soil, the losses are greater than the gains unless manures are applied.

One of the most important principles of manuring is to restore to the soil again, so far as is economically possible, what has been taken from it. This is done by the dung and waste of the farm. If all the residue from the consumption of the crops produced could be restored to the soil, little else would be needed to keep up its fertility. We would then imitate very nearly what takes place in a state of nature. In a simpler state of society, when the great bulk of the population lived on the land, when urban communities were comparatively small, and when modern sanitary systems of sewage disposal were not in existence, the great part of the manurial materials of the food consumed both by man and his domestic animals was restored again to the soil. Under such conditions the dung and composts available on the farm restored to the soil again most of what had been taken from it in crops, and the conditions on land in its natural state were in this respect reproduced. None of the modern artificial manures were available, and under such conditions they were far less needed than under those which at present prevail in this country.

Under present conditions the great bulk of the population lives in towns, and much of the produce of the country is removed to towns as corn, meat, milk, &c. Its manurial waste is not restored to the country but is sent down the drains, and so far as agriculture is concerned is wasted. Even in the country and in villages, much of what was at a period not very remote restored to the land, is treated in accordance with modern sanitary requirements and lost to agriculture. At the same time culture has become more intensive and land is better drained.

For all these reasons the balance which has to be made up by manures is greater than formerly; and as the quantity of 'natural' manure is in proportion less, the need of artificial fertilizers is greater.

The more intensive the culture the greater the crops grown, and the greater the amount of material sold off the land the greater the amount of manure which must be brought back to the land again in some form to keep up its fertility. Thus the market gardener needs to bring much more manure to his land from outside than the farmer. He crops his land more closely and intensively than the farmer, and he sells nearly all his produce off the land. In return he purchases much dung from horse-keepers and others in towns, and buys much other manure.

The old manuring consisted practically of the use of dung, composts, and lime. These are sometimes called 'natural manures'. Under modern conditions we can supplement these by a great variety of artificial manures. But under such a system of farming as prevails in most parts of this country where many cattle are kept, and where much of the produce of the farm is consumed on the farm by stock, the farmyard manure should with lime form the basis of the manuring, and artificial manures should be looked upon as merely secondary and supplementary substances to make up deficiencies and meet special requirements.

Dung and lime are among the manures which serve for both the main functions performed by manures. Dung is an all-round manure, and not only supplies the soil with nitrogen, phosphates, potash, lime, and all the other chemical constituents which plants require from manures, but it improves the texture, warmth, water-holding power, and general effectiveness of the soil as a medium for the growth of crops. It supplies humus, on which the condition and kindliness of a soil so much depend. Lime supplies crops with an essential element calcium, but that is only of secondary importance as compared with its value as an improver of the texture of the soil, and of its character and efficiency as a medium for the action of other manures.

On the other hand, most artificial or chemical manures are of use only because they supply certain ingredients of plant food. As a rule they have little or no effect as improvers of the texture and condition of the soil—some of them indeed are actually injurious in their mechanical effects on the soil.

Besides the humus which is added to the soil in dung, a still larger amount is obtained from the crop residues left in the soil. Crop residues are most important in keeping up the condition of the soil by supplying it with the necessary organic matter by the decay of which humus is produced. The greatest amount of humus given to the soil in this way is in the sod which is ploughed down when land is broken up again after lying one or more years in grass, but much organic matter is also obtained from the stubble of corn crops and the leaves, stems, and roots of turnips, mangels, or potatoes. These residues of crops really form a most valuable kind of green manuring. When dung is not available this process can be carried further and the soil kept in good heart and condition by growing crops and ploughing them in as green manuring. If a suitable leguminous crop is grown, this also adds to the stock of nitrogen in the land. By using artificial manures to supply the necessary constituents of plant food, and green manuring to supply the necessary humus, land can be kept in thorough condition without any dung.

The addition of crop residues to the land not only keeps up the stock of humus, but restores to the soil again much of what has been temporarily taken from it in the crop. Thus the tops of a crop of turnips contain a large part, nearly half, of the nitrogen taken from the soil by the crop, as well as a considerable amount of phosphate and potash. When the tops of an average crop of turnips are left on the soil they restore to it as much nitrogen as is contained in a dressing of 2 cwt. of sulphate of ammonia, as well as the equivalent in potash of about 3 cwt. of kainit, and the equivalent in phosphate of nearly 1 cwt. of 26-per-cent soluble superphosphate. Land on which the tops are left, therefore, is always in much better condition for the succeeding crop than that from which they are removed.

The purchase of food for consumption on the farm is equivalent to the purchase of manure. It is a principle to be remembered that the purchase of food and the purchase of manure are to some extent interchangeable. Every ton of concentrated food, such as linseed cake, brought to the farm is equivalent to a certain amount of manure, and should in so far diminish the necessity for the purchase of manure. A ton of linseed cake contains a certain amount of nitrogen, phosphate, potash, lime, &c., taken from the soil where the linseed was grown (see OIL-CAKE MANURES). These should to a very large extent be recovered in the dung of the farm where the cake is used, and really constitute a transference of the elements of fertility from the land where the linseed was grown to the land where it is consumed. So much is this the case that on farms where a large head of stock is fed by the use of purchased feedingstuffs it should be unnecessary, if the dung is properly made and utilized, to purchase any manure except perhaps a little phosphate. Not only can the condition of the soil be kept up under such conditions, but even with the most intensive farming it can be built up and the land enriched and improved.

Manuring is essentially an economical question, and the final test, as in all applied science, is the economical one, Does it pay? It is possible to use manures so as to increase crops and build up fertility and still use them at a loss, or at any rate not to the best advantage. The financial side of the question must never be lost sight of. If this is kept in view it will be found that the manures to be used must vary with market conditions. The perfect rule is to use what will produce the desired result most cheaply. If nitrate of soda becomes very dear, then other sources of nitrogen which are cheaper should be substituted for it. So if dung becomes too dear, because the cost of carriage,

say, to a certain field is very heavy, then green manuring and artificials should be substituted for it. Or if purchased feedingstuffs become very dear, less of them should be used, and more food grown on the farm by the use of more purchased artificial manure.

To a certain extent our crop rotations are and should be based on the necessity of economizing soil fertility or economizing manure. Where fertility is cheap, as in new countries, crops are grown without regard to economizing fertility, and manures and rotations are scarcely considered at all. But as population increases and fertility becomes more valuable it is conserved in various ways, and crops are grown in such order as to cause as little exhaustion as possible. Though agriculturists were scarcely conscious of this principle in forming their rotations, they have to a very large extent unknowingly acted upon it. In modern times conscious attempts have been made to improve our rotations in the direction of greater conservation of soil fertility, without loss of any other thing of value, by the introduction of catch crops; and by the greater use of leguminous crops, which increase the stock of combined nitrogen by drawing upon the atmosphere. The principles of manuring constitute a wide subject, which cannot be adequately dealt with in a short article, but many other matters bearing upon this subject will be found disseminated through these volumes in the numerous articles on manures; see, for instance, those on ARTIFICIAL MANURES and FARMYARD MANURE. [J. H.]

Manuring of Crops.—The manuring of the various crops is fully considered in the separate articles on each crop, and in the general article MANURING, PRINCIPLES OF.

Manyplies, one of the divisions of the stomach of ruminants, and commonly called the third stomach. See OMASUM.

Maple (Acer) is a genus of the family Aceraceæ, characterized by having opposite, stalked, simple leaves without stipules, palmately veined and often palmately lobed; small regular flowers, often greenish and generally hypogynous, with 4 or 5 sepals and separate petals, and 4 to 12 (usually 8) stamens; and a dry 2-winged samara fruit breaking into two separate 1-winged halves whose single closed chamber generally contains one seed. Over eighty species of Maples are known, mostly indigenous to the temperate part of North America, while eight occur in Central Europe. The only species indigenous to Britain is the Common or Field Maple (*A. campestre*), a small tree or shrub common in hedgerows and coppices, where its 3- to 5-lobed leaves assume a rich red tint in autumn. The only two species of importance in Britain as forest trees are the Maple or Norway Maple (*A. platanoides*), and the Scots Plane, Sycamore, or Great Maple (*A. Pseudo-platanus*—see art. on SYCAMORE), both introduced from the Continent, but long thoroughly naturalized. These can easily be distinguished at any time of the year, by the Norway Maple (1) having brown-red buds in winter, (2) flowering along with, or just before, the flushing of foliage in spring, (3) having 5- or 7-lobed very pointed leaves, and (4) having a wide-angled samara with flattened seed-chambers; while the Sycamore has green buds, flowers after the foliage is completely flushed, has 5-lobed leaves, and acute-angled samaras with globular seed-chambers. The leaves of Norway Maple are very like those of the Plane tree, but can easily be distinguished as they are opposite, and all the main nerves of the 5 or 7 lobes extend to the top of the leaf-stalk (whereas in the Plane the 5- or 7-lobed leaves are alternate, and the main nerve of the lowest lobe on each side runs into the main nerve of the next lobe above, while the leaf-stalk is large and hollow at its base to enclose and conceal the new bud, appearing only after the fall of the old leaf). Several other Maples are, however, frequent in parks and gardens, having been introduced from North America for purely ornamental purposes. These include the Sugar Maple (*A. saccharinum*), yielding 'bird's-eye maple' for furniture; the Silver Maple (*A. dasycarpum*); the Red Maple (*A. rubrum*), with reddish flowers and scarlet or orange foliage in autumn, and the Ash-leaved Maple or Box Elder (*A. Negundo*), with pinnately compound leaves of 3 or 5 leaflets, one of the varieties of which has white and green variegated foliage.

The Norway Maple flushes its foliage early in spring, grows rapidly, and assumes a bright-yellow autumn tint contrasting well with the dark-green and russet colour of most other trees. It is less heavy and massive, and less formal in outline than the Sycamore. It is a hardy species, thriving well in the north, and stands the sea breeze well; but it does not grow so well on hilly land as the Sycamore. It does best on a fresh sandy loam, especially if this contains some lime, and grows well on any kind of fresh soil that is well drained. Its wood is fine-grained, close, heavy (sp. gr. 0·75 seasoned), and takes a good polish. While young it can endure a large amount of shade, but afterwards needs a free growing-space as a timber tree. It is not suited for forming pure woods, and does best when mixed with other broad-leaved trees (especially Beech), when it reaches maturity at about seventy years of age. From about thirty-five or forty years onwards it produces good seed freely, and almost annually. The seed can either be sown in drills in autumn when gathered, or else stored with sand or mould for spring sowing, but in this case it loses considerably in germinative power. One-year seedlings are transplanted into nursery lines till needed for planting out. Seedlings come up freely in woods where there are Maple trees, and stand a large amount of shade when young; but from want of protection they are generally destroyed by rabbits. [J. N.]

Maple.—Parasitic Fungi. See SYCAMORE—PARASITIC FUNGI.

Maps, Geological.—The earliest geological maps were intended to represent, by signs, shading, or the use of various colours, the mineral nature of the rocks exposed at the surface. They were prepared to assist mining or agricultural operations, as well as to express the results of purely scientific enquiries. The Rev. V. Sampson, for example, inserted a simple

geological map in his Statistical Survey of the County of Londonderry, published as early as 1802, in which colours are used for rock-formations, including the superficial clays and gravels now known to us as 'drifts'. In the absence of

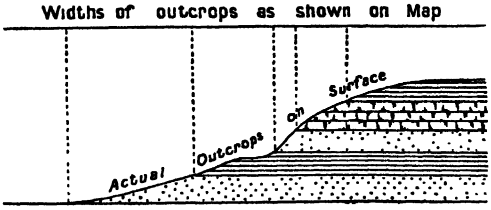


Fig. 1

Section of stratified rocks, showing how the outcrop, as projected on a map, may appear narrower than the width of the actual surface exposed; also, how beds of equal thickness may yield outcrops of very different widths, owing to variations in the slope of the hillside on which they emerge.

organic remains, geological maps are still constructed on this basis; but the discovery made by William Smith at the end of the 18th century that strata of the same geological age contain similar types of fossils led to the drawing up of stratigraphical maps on a new basis. ' colours were now used to express beds of p ticular ages, without reference to their mine nature. On small-scale maps at the present (a dark-green band may thus represent Lo Cretaceous strata, without giving any indicat that these consist of sands in one place and stiff brick-clays in another. On maps of lar scale, say one inch to one mile, attempts made to show subdivisions that depend mineral character, as well as those that depe on a difference in the included fossils. Do often coloured, are thus added where sands p vail; and it has long been customary to repres limestones, even when occurring in a scatte manner, by a blue tint superposed on that u for the main formation. The lines along wh coal-seams come to the surface may be indica by thick black lines upon the map, while we marked mineral veins may be shown by lines gold.

By an accepted convention, dating from 18 when William Smith published the first gene geological map of England, the colours used i different formations in the British Isles ha usually some relation to the nature of the c posits. The London Clay is thus coloured

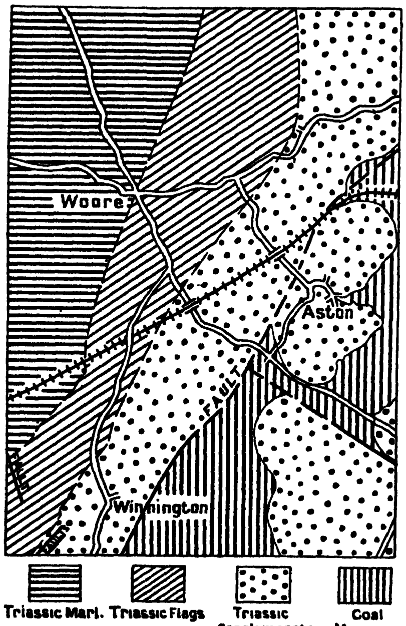


Fig. 2

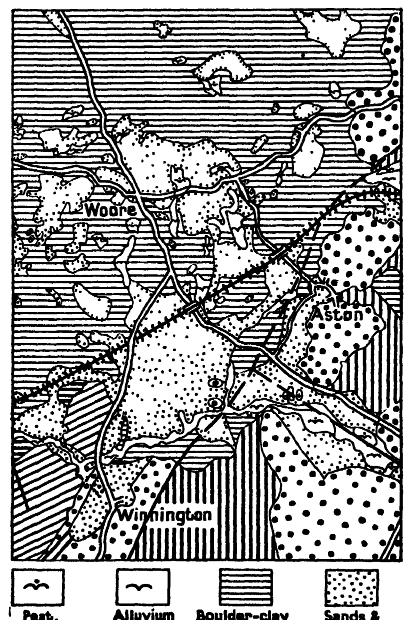
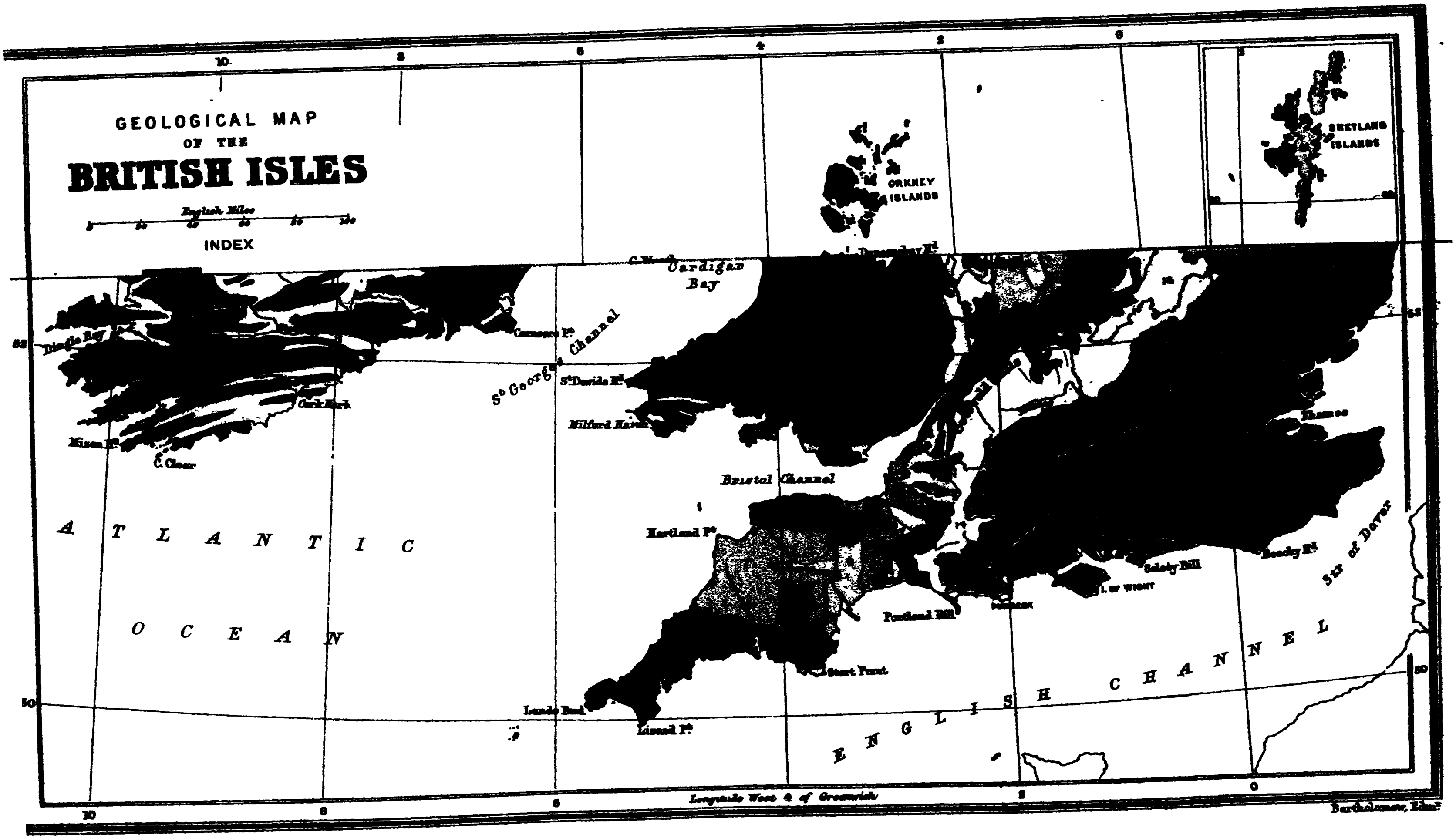


Fig. 3

Maps of the same area as in fig 1, showing 'solid geology' (fig. 2), and superficial deposits or 'drifts' (fig. 3). From Sheet 123 of the Geological Survey of England, solid and drift editions (by permission of the Controller of H.M. Stationery Office), the colours of the original maps are here represented by conventional shading. The boundaries of the strata beneath the superficial deposits are shown in the published sheet, but are here omitted. Where no superficial deposits appear in any area of the drift map, the 'solid' rock is indicated since it practically forms the surface.

muddy brown, the Silurian beds are coloured in various tints of violet, to resemble slates, while the Lower Greensand series is shown in strong green. Pinks and reds have been reserved as far as possible for igneous rocks. The colouring of Continental maps is on much the same basis, but latterly tints have been introduced tha provide stronger contrasts.

The *outcrop*, or area over which a bed extend at the surface, obviously varies with the dip o inclination of the strata and with the slope o the surface on which it emerges. A horizonta


GEOLOGICAL MAP
OF THE
BRITISH ISLES
English Miles
INDEX
ORKNEY ISLANDS
SHETLAND ISLANDS
Cardigan Bay
St George's Channel
St Davids Hd
Milford Haven
Bristol Channel
Hartland Pt
Lands End
Lizard Pt
Start Point
Portland Bill
Selsey Bill
I. of Wight
Beachy Hd
Thames
Str of Dover
Dingle Bay
Mizen Hd
C. Clear
Cork Harb.
Carnsore Pt
ATLANTIC
OCEAN
ENGLISH CHANNEL
Longitude West 4 of Greenwich
Bartholomew, Edinr

B Sa.

bed exposed on a horizontal surface would spread without limit in all directions, though it might be a foot or less in thickness. The same bed, uptilted vertically, would come out on a horizontal surface as a mere band, with an outcrop 1 ft. in width. The diagram (fig. 1) will show how the slope of the surface affects the actual outcrop, and also how the outcrops shown upon a geological map may often be too narrow. A bed which retains the same thickness has thus various widths of outcrop on a map, none of which can be wider than the real outcrop in the field. The cause of these variations can be ascertained only when both the form of the surface, as shown on a contoured map, and the dip of the bed are known.

Dips (see art. Dip) are shown by arrows on the map, with a number attached indicating degrees of inclination from the horizontal. These signs of course tell us nothing about the slope of the surface, but record the slope of the bed underground—a very important fact when we are dealing with a rock of economic importance or with water supply.

Faults, or lines along which the beds have been broken through, are often noticeable on the map by a break in the continuity of the outcrops. The Britannic Surveys indicate faults by white lines.

Such maps as we have been describing record the 'solid geology' of a district, *i.e.* the grouping of the rocks that underlie the comparatively modern 'superficial deposits'. They are of immense value from an educational, engineering, or mining point of view, but they altogether fail to meet the requirements of the agriculturist. It has been customary to represent on them the alluvial flats of rivers, reclaimed lands along coasts, and peat bogs; but all the deposits of glacial gravel and boulder clay, the detrital 'clay with flints' of southern England, old river-alluvium cut through by the present streams, and other superficial coatings which may be 100 ft. or more in thickness, are omitted from geological maps on a small scale, and from our official one-inch 'solid' maps. Latterly, however, *drift maps* have been issued in England and Wales side by side with those showing solid geology, and these reveal, in admirable detail, the materials from which the soils are actually derived. The publication of a series of drift-maps on a larger scale would be a very costly undertaking; but the original maps drawn up by the geologists on the scale of six inches to one mile can be consulted at the offices of our Surveys, and copies can be procured on payment of the cost of colouring. Such copies are made on the Ordnance maps, on which the boundaries of individual fields are marked, and they serve as an excellent basis for the appreciation of the subsoils on a farm and for the construction of true soil-maps (see also art. Soil-maps). [G. A. J. C.]

Marble Gall-fly, a fly whose maggots cause the well-known galls on oak trees. See Cynips kollari.

March, Calendar of Farm Operations for.—

1. Southern Britain

Arable Land.—This is one of the busiest months of the year, as it is now that the bulk of the spring crops are put in. On sheep-folded root land intended for barley or oats the plough should be kept close up to the pen. Either oats or barley follow the sheep-fold in the rotation, or oats follow lea ploughed up in winter, and barley comes after winter-ploughed wheat stubble with a topdressing. Wheat can be topdressed with nitrate some time this month. Potatoes are planted out about the end of the month, having been sprouted in the warmth and in darkness in a shed. Tares for sheep folding and soiling in summer are now sown. Cabbage seed is sown in plots for transplanting later on.

Grass and clover seeds are sown over the young wheat, oats, or barley, and harrowed in during this month if the nurse crop is advanced enough. Land for mangolds and other roots should be actively worked and manured during this month, and at the end of the month the first break of kohlrabi can be sown. Beans, late peas, flax, hemp, carrots, sainfoin, and lucerne are all drilled now, but the latter are more often left till next month. In hop-growing districts the young hops are being planted.

Farm accounts should be squared up, as Lady Day is one of the most important term days.

Grass Land. — If other grass is forward enough, shut off the land intended for hay. The earlier that the grass lands are shut up for hay the better chance there is for it. Water meadows by this time should be providing a good bite for ewes and lambs. If the season is favourable the work can be got forward by trapping the moles and then harrowing and rolling the fields for hay.

Topdressing and liquid-manuring of grass at this time does more good than at any other time of the year.

Stock.—In cheesemaking districts the cows are calving and the cheesemaking has begun.

The cows may be turned out to grass for a few hours daily, but are still on winter rations and in the byre at night.

Horses are getting full rations now, supplemented with carrots and bran mashes, as they are working hard and on full time. Mares are near foaling. Fat bullocks are sold off as they come ready. Sows are near farrowing and require to be watched.

Lambing is in full swing.

Young store stock still require to be housed at nights.

Fowls become broody now, and the first batches of chickens, &c., are hatched off by the end of the month. Turkeys usually begin to lay during March, and need watching to see where they have their nest. [P. M'C.]

2. Northern Britain

Over a wide extent of the country this month is generally looked on as being the beginning of the sowing and planting season. During all dry periods, or more especially those with a little frost, bean sowing should be pushed forward with as much energy as possible. In the beginning of the month the frost may be severe enough to stop this work during the greater part of the day. In such circumstances the land

should be re-harrowed as soon as it is sufficiently softened by the rays of the sun; and if this is done each afternoon, there will rarely be as much frost at this time of the year as will stop drilling next day. Beans always do best where put in as early as possible, provided the land is sufficiently dry, and the same applies to peas. While beans are rarely sown unless on clay soil, peas on the other hand are generally sown on light friable land. On that account they can often be sown when it is impossible to do anything at bean sowing. The planting of early cabbages should be finished as early in the month as possible, and late varieties may be planted from the last week forward. Early planted cabbages rarely suffer from attacks of the cabbage-root maggot, as by the time the eggs are laid the root of the cabbage has become so hard that the young maggots fail to pierce it, and so die of starvation. In early districts subject to little frost in March, potatoes sprouted in boxes are planted during the whole month; but farther inland and in more elevated districts, potato planting rarely begins till near the end of the month. If the weather is dry, grain sowing also begins in the end of the month, but in most years the bulk of it is deferred till the beginning of next month.

When the weather is unsuitable, either from wet or frost, for proceeding with sowing or planting, all arrears of ploughing should be pushed forward; and if sufficient seed grain or potato seed has not been provided, these should at once be prepared, as there is no time to look for them when the land gets into a condition for sowing or planting. Turnips being fed off by sheep should have the land ploughed close up to the flakes. Stocks of feeding sheep should be gradually reduced as the supply of food becomes exhausted, so as not to have too many to dispose of at one time.

Ewes due to lamb should have more than the usual care devoted to them, and where there is no natural shelter, some other should be provided for them. This is especially needful in wet weather, as although a young lamb can easily stand a considerable amount of dry cold, it at once succumbs if the cold is accompanied by wet. On most breeding farms a large proportion of the cows drop their calves this month, and before the calves begin to arrive the place in which they are intended to be kept should be thoroughly cleaned out and whitewashed. The same provision should also be made for mares which are in foal. It is a good plan to allow mares in foal to occupy their box a month or two before they are due to foal. [J. S.]

March, Calendar of Garden Operations for.—

1. SOUTHERN BRITAIN

Whenever the weather and the condition of the soil are favourable to outdoor work, all important operations that have been delayed should be pushed to a finish before the end of this month. Transplanting trees and shrubs, especially fruit trees and roses, may be safely performed in March; but should the weather be dry they require to be well watered in, and, if convenient, a good mulch of well-rotted man should be given to prevent the soil moist from evaporating. The pruning, training, ε nailing of fruit trees must be completed bef the end of the month, but roses are best left April. Where grafting is done, this is the b time to work hardy fruit, such as apples, pe plums, cherries, and hardy trees and shrubs ge rally. An early spraying to keep down fung diseases and insect pests should be given bef the end of the month, prevention in this bei better and easier than cure. Birds are oft destructive to fruit buds in March, attacki them as they burst their winter envelopes. some districts they have been known to devo every flower bud on plums in about a fortnig in March. Seeds of the following should sown out-of-doors during the month: Aspa gus, broad beans, borecole, brussels sprou early cabbages, carrots, leeks, lettuces, onio parsley, parsnips, peas, radishes, savoys, scor nera, sea kale, spinach, and turnips. Sowings a frame should be made of cauliflowers, cele capsicum, marjoram, tomatoes for the late cr and cucumbers. The main crop of potat should be planted before the end of the mor except in districts liable to late frost, when m April will be soon enough. Early cucumbe will now require a high temperature and otl conditions conducive to quick healthy grow Melons, figs, peaches, nectarines, and vines w also need close attention, the free use of t syringe whenever the weather is favourab care in the application of artificial heat bo day and night, and in the use of the ventilat being most important. A dry atmosphere often the cause of much mischief in the forci house; and where the required temperature maintained by much artificial heat, injury certain to be done to the plants unless they a liberally supplied with water at the roots, a the atmosphere about them is kept constant moist. The propagation of plants of all kinc either by means of seeds sown in pots and pa under glass or from cuttings, should be push on with vigour during March. A hotbed a frame is very useful for this purpose. You growths of many kinds of plants, if set in sanc soil in a moist, warm frame, strike root readi at this time of year. Spring-flowering plan in beds outside, such as tulips, hyacinths, ear gladiolas, anemones, polyanthuses, wallflowe and early phloxes, will require attention, brea ing up the surface soil about them and affordi a little protection should the weather be col A garden mat pegged over the bed, or the sprin ling of dead leaves or bracken over the growi plants, may save them from a cold check. Seed of many summer-flowering plants may be sow in the open ground towards the end of th month. All the hardier annuals are best whe sown now, thinning the seedlings as they becon large enough. [W. W.]

2. NORTHERN BRITAIN

While there is a diversity of opinion regar ing the advantages or otherwise of autumn dig ging and trenching, there is not now time t spend on academic discussions thereon, as garde

work in all departments presses hard during this month. Therefore as soon as winter crops get used up and cleared off, get the quarters manured and dug—or trenched—in readiness for another crop.

In districts where the soil is of a light friable character, the sowing of the seeds of the main crops of vegetables should be performed as early in the month as the conditions of the soil and weather permit. In those places, however, where the soil is naturally stiff and cold, the middle of the month will be quite early enough to begin these operations as a rule, as nothing is gained—in fact, much may be lost—by sowing seeds of plants, which naturally belong to warmer climes, too soon. Rather wait a little, until the sun with its increasing heat has set in motion those agents whose activities are indispensable in the development of all life, than run risks. The *best* time for planting and sowing in any district can only be learned through experience and by close observation.

Further, never begin working the soil for the sowing of fine seeds when the surface is clammy either immediately after rain or a touch of frost in the morning. It will pay to wait a few hours until the surface dries. Frequently in places where the soil is naturally heavy and damp, a difficulty is found in getting the finer seeds to braird satisfactorily. An excellent way to overcome this trouble is, cover the seeds with some prepared mixture of a lighter nature than the natural soil, such as spent potting soil, leaf mould and sand, or wood ashes. Any of these, either alone or mixed and passed through a half-inch-meshed riddle, will be found serviceable, and, if spread over the seeds by the hand, a barrowful goes a long way.

It is a common custom, especially in small gardens, to make only one sowing of the various seeds. While this may be good enough practice for such crops as leeks, onions, parsnips, and a few others, it is not so in the majority of cases where a long supply of fresh succulent vegetables is desired. In the case of cabbages, cauliflowers, beans, carrots, turnips, &c., two or three sowings may be required, while in regard to peas a sowing should be made every ten days or so, from the time of the first sowing until the beginning of June. The seeds therefore should be duly apportioned and arranged for successional sowings. An hour spent in so doing will be well spent.

As opportunity offers, plant potatoes, also autumn-sown cabbages, brussels sprouts, and cauliflowers. The latter will in all probability require some slight shelter for a time, especially if the situation is exposed to winds In cold late districts autumn-sown brussels sprouts usually produce the most satisfactory crop.

Where onions and leeks were sown in heat, the seedlings will now be ready for pricking out in pots, boxes, or frames. Use light rich soil, water very carefully, and keep the plants in a light situation with the view of having strong sturdy stuff to set out at the proper time.

The propagation of bedding plants must now receive attention. Where a fully equipped propagating house is not available, there is nothing better than the oldfashioned hotbed and frame. Dahlia tubers should now be started. See that seedlings, especially lobelias and begonias, do not become too crowded and drawn before being 'pricked off'.

Syringe vines twice a day with tepid water until the buds are fairly started. Once the growth is fully in action a gentle dewing with the syringe will suffice, provided due attention is given to atmospheric moisture. Unless for special purposes, do not force the vines with strong temperatures. These remarks on vines are intended for those who have limited accommodation and where vines are to be treated on more natural lines. When the shoots are about 2 in. long and showing the leaf, and probably the embryo bunch, rub off those not desired. Usually one to a spur is sufficient. As the growth extends, the tip of the young shoot should be pinched out two or three joints beyond the bunch, taking great care not to injure the developing leaves. The temperature should be regulated according to the outdoor conditions of the atmosphere. 50° to 55° F. at night is quite high enough.

Peach trees coming into bloom should in dry or windy weather be dewed morning and evening with the syringe. This will not only tend to keep down green fly and red spider, but will materially assist the 'setting' of the fruit. Immediately the flowering is past, start 'disbudding'. Begin by rubbing off the worst-placed buds — those being in the front or back of the plane of the trellis—doing the work gradually but systematically.

The floral department outdoors will likewise require attention. The remarks regarding the sowing of culinary vegetables too early applies equally to seeds for flower-garden purposes, and about the end of the month is soon enough for most species of annuals.

The pruning of roses ought to be regulated by local conditions and requirements. In places the pruning may be done early with safety, whereas in others towards the end of the month will be found soon enough to give the best results. [J. WH.]

March Fence.—The term 'march fence', that is, a fence marking the boundary between two estates, is peculiar to Scotland and is not known to the common law, being the creature of statute. No man can compel his neighbour to erect a fence to prevent his cattle from straying, though from time immemorial the law has recognized a claim for damage done under such circumstances. At a very early period the Winter Herding Act of 1686 (which see) was passed to enforce the right.

A few years prior to the passing of this Act, namely in 1661, the first Act directly bearing on the erection of march fences had been passed. That Act provides that 'where enclosures fall to be upon the border of any person's inheritance, the next adjacent heritor shall be at equal pains and charges in building, ditching and planting that dike which parteth their inheritance'. In order to get the benefit of the Act, timeous notice must be given to the neighbouring proprietor to enable him to protect himself

from unnecessary expenditure. It has been held that the Statute only applies to cases where the advantage is mutual, though not necessarily equal, and that the Court will not insist on a march fence being erected if the expense to the one individual would be quite disproportionate to the advantage to be obtained by him. So, too, the fence must be necessary, and thus if the boundary be the edge of a precipitous cliff it will not be authorized. It has been decided that the Statute applies not only to dry marches but also to cases where the boundary between the estates is water. In such cases it has been held that if the burn is so small as to be negligible, the Court might disregard it altogether and put the fence on the ground of the person seeking to put the Statute in force, or in the option of the defender partly on the one side and partly on the other. If the fence is not erected on the exact march but on one side of a stream, it must always be on the side of the party seeking to put the Statute in force, unless the other party is agreeable to another line. Where the boundary is a river of any size, it has been held that the Act would not apply, since in such cases the size of the stream is not negligible, and the fence wherever erected could not reasonably be held to be a march fence. The Act apparently contemplated only a feal dike, since it speaks of building, ditching and planting a dike; but the Court in construing the Act will take into consideration the fence which is most suitable to the ground, and will order the erection of it. If a mutual fence has once been erected, the fact that one of the proprietors has ceased to occupy his ground in the way in which it was occupied at the date of erection will not deprive him of his right to demand the upkeep of the fence at mutual expense.

In 1669 an Act anent the enclosing of ground was passed which, after narrating the difficulties which had arisen in the application of the Act in 1661, 'where the marches are crooked or unequal, or where any part of the bordering ground is unfit or uncapable of bearing a dike or receiving a ditch, or hinders the completing of the enclosure in an equal line', enacts 'that whensoever any person intends to enclose by a dike or ditch upon the march betwixt his lands and the lands belonging to other heritors contiguous thereunto, it shall be leisom to him to require the sheriff to visit the marches alongst which the said dike or ditch is to be drawn, who is hereby authorised, when the said marches are uneven or otherwise uncapable of ditch or dike, to adjudge such parts of the one or the other heritor's ground as occasion the inconveniency betwixt them from the one heritor in favor of the other, so as may be least to the prejudice of either party; and the dike or ditch to be made to be in all times thereafter the common march betwixt them; and the parts so adjudged *respectivé* from the one to the other being estimate to the just avail and compensed *pro tanto*; to decern what remains uncompensed of the price to the party to whom the same is wanting; and it is hereby declared that the parts thus adjudged *hinc inde*, shall remain and abide with the lands or tenantries to which they are *respectivé* adjudged as parts and pendicles thereof in all tir coming'. The proceedings under this Act mu as in the case of the former Act, be reasonab and of mutual advantage. It has been held th the sheriff has not merely the power to mal marches straight which before were crooke but that he is entitled to consider the conv nience of parties and to exercise a latitude fixing the line.

Apart from Statute a march fence may orig nate by agreement express or tacit. Withou applying to the sheriff, heritors may agree wi each other to erect a fence upon their properti at mutual expense. Or, it may be that, withou express agreement or contract, a march wall other fence by which adjoining properties a *de facto* divided has from time immemorial bee held and treated as if originally erected und the Statute or by express agreement, and the by implied contract the same obligations ma attach to the heritors or to their successors their several properties. In this way, what w originally merely a boundary between two fiel belonging to the same proprietor may, by division of the property, come to be a marc fence between two different proprietors.

A march fence is common and indivisibl and there is a common obligation on both pr prietors for the joint expense of the upkeep ar repair. When a fence has fallen into such di repair that the man of skill to whom it had bee remitted to advise, reported that it would l necessary to rebuild it, it was held that tl sheriff had power to make an order for rebuil ing if in his opinion it was more economical ar more efficient to adopt this course. As in tl case of erection, so in the case of repairs, it essential that notice be given to the adjoinir proprietor before any work be done.

While a march fence is usually partly c one property and partly on another, it may l entirely on one estate; and the fact that a marc fence is not on the true line of the march but c an adjoining line, more or less divergent, rais no presumption that the fence is the bounda of the two properties unless there is somethir in the titles to that effect, or unless proceedin have been taken under the Act of 1669. Tl fact that the fence is entirely on his neighbou ground does not entitle the adjoining propriet to object to pay his share of the fence or of tl repairs, provided it be truly a march fence.

It has been decided that these Acts only app to proprietors, and accordingly an action by crofter under the Crofters' Holdings Act, to ha his landlord ordained to pay half the expens of erecting a march fence between the croft ar the landlord's adjoining property, was throw out on the ground that the crofter was not proprietor and could not therefore take adva tage of the Acts. [D. B.]

March Moth, a moth whose larvæ inju fruit trees of all kinds. See ANISOPTERYX ÆSC LARIA.

Mare. See arts. BROOD MARE; HORSES- REARING, FEEDING, AND MANAGEMENT OF; al art. on BREEDING.

Mare's-tail (*Hippuris vulgaris*) is a smoo perennial aquatic herb of the dicotyledon cla

often found in canals, watery pools, and shallow ditches. There is a stout horizontal creeping stem (rhizome) from which the green shoots, with spongy stems as thick as a goose quill, rise through the water, and project to a height of 8 or 10 in. These green shoots are quite simple (not branched), and are easily recognized by their numerous whorls of about eight flat narrow (linear) pointed leaves. In July, the flowers appear, seated in the axils of the leaves; they are quite inconspicuous and destitute of petals; each flower bears one stamen, one style, and a simple unlobed ovary containing one ovule. The whole plant has a general resemblance to a Horsetail (Equisetum), but there is no real affinity, since Mare's-tail is a flowering plant, and Horsetail a cryptogam with no flowers. Wild duck sometimes feed on Mare's-tail.

[A. N. M'A.]

Margarine.—Margarine as defined by the Margarine Act of 1887 'shall mean all substances, whether compounds or otherwise, prepared in imitation of butter, and whether mixed with butter or not; and no such substance shall be lawfully sold, except under the name of 'margarine''. A more recent regulation makes it unlawful 'to manufacture, sell, expose for sale, or import any margarine the fat of which contains more than 10 per cent of butter fat'. The law not only makes the word margarine to include 'butterine' and the substances made from beef suet, but also includes all the more recent preparations which, to make up for lack of the supply of the original raw material, now often include pork fat, veal fat, cotton-seed oil, olive oil, earthnut oil, sesamé oil, and cocoanut oil, as well as many other substances. Margarine was originally prepared by a Frenchman named Mège-Mouriès, at the instance of Napoleon III, with the object of obtaining a wholesome cheap substitute for butter for the poorer inhabitants of Paris. Since its first introduction in 1872 its sale has assumed relatively enormous proportions.

In the best factories margarine is still made from beef fat which is finely divided by a mincing machine or 'hasher', passed into large water-jacketed tanks, and heated to a maximum temperature of 102° F. Most of the impurities are allowed to settle with the water, and the clear yellow melted fat, having been freed from floating impurities by skimming, is run off into wooden vessels, and the stearin used for candle-making then crystallizes out. The oleomargarine at this stage is quite tasteless, and has therefore to be churned up with milk, coloured with annatto, and rolled with ice. Before churning, the oleo is melted, and then when well emulsified by running the churn at a high speed, the other ingredients are added.

It is of interest that in modern French and Belgian methods of manufacture emulsification is aided by the natural enzyme obtained by adding a small proportion of the udder of a cow macerated with water. In this method a thick 'cream' is obtained, and can afterwards be churned as in the case of cream obtained from milk.

The following is an analysis of commercial margarine:—

Water	12·0	per cent.
Stearin	38·5	,,
Olein	25·0	,,
Palmitin	18·3	,,
Butyrin, caproin, and caprylin	0·3	,,
Casein	0·7	,,
Salts	5·2	,,
	100·0	

Compared with butter, the chief differences in composition are the very low percentage of volatile fatty acids, the high percentage of insoluble fatty acids, and the high molecular weight. There are also other practical differences in flavour, digestibility, &c. These make margarine inferior to butter in value, but as the price is also lower, good margarine serves a very useful purpose when sold under its proper name and not used for the purposes of adulteration. For methods of analysis see BUTTER.

Margarine cheese is defined by the Act of 1899 to mean any 'substance, whether compounded or otherwise, which is prepared in imitation of cheese and which contains fat not derived from milk'. See next article.

[J. GO.]

Margarine Acts.—The manufacture, importation, and sale of butter, margarine, and similar substances have been regulated by the Sale of Food and Drugs Acts, some of which relate specially to these articles, and the latest of which is the Act of 1907 (7 Ed. VII, c. 21).

Margarine is defined as any article of food, whether mixed with butter or not, which resembles butter and is not milk-blended butter. Margarine cheese is defined as any substance prepared in imitation of cheese which contains fat not derived from milk, while milk-blended butter is defined as any mixture produced by mixing or blending butter with milk or cream, other than condensed milk or cream. Factories in which any of these substances are manufactured, including butter factories, and also the premises of any wholesale dealer in margarine or margarine cheese, must be registered with the local authority, who must notify the registration to the Board of Agriculture. Any officer of the Board of Agriculture or Local Government Board is entitled to inspect such premises at all reasonable times. Where premises have been registered as a butter factory, an officer of the local authority authorized to procure samples under the Acts, shall, if specially authorized by the local authority, have similar powers of entry and inspection. Moreover if the Board of Agriculture have reason to believe that any process of manufacture or wholesale dealing which could only be lawfully carried on in premises registered under the Acts, is being carried on in unregistered premises, or that butter is, by way of trade, either made or stored in any premises and that inspection is desirable, the Board may specially authorize one of their officers to inspect such premises. An officer specially authorized, whether by the Board or the local authority, must exhibit his authority to the occupier of the premises on demand. Premises cannot be used as a butter factory if they form part of, or communicate,

otherwise than by a public road, with any other premises which require to be registered under the Sale of Food and Drugs Acts, or in which milk-blended butter is manufactured. Manufacturers of, and wholesale dealers in, margarine or margarine cheese require to keep a register showing the quantity and destination of each consignment of such substances sent out, which register is open to inspection by any officer of the Board of Agriculture. The occupier of a butter factory is prohibited from keeping on his premises any substance intended to be used for the adulteration of butter, and if any oil or fat capable of being so used is found on the premises, it shall be deemed to be intended to be so used, unless the contrary is proved. The limit of butter fat in margarine is restricted to 10 per cent. The limit of moisture in factory butter or margarine is fixed at 16 per cent, while in milk-blended butter it is fixed at 24 per cent. By the Act of 1899 it is made an offence to import any of the following articles unless the packages, cans, tins, or other receptacles in which they are contained are conspicuously marked in terms of the statutes, viz.: margarine or margarine cheese; adulterated or impoverished butter (other than margarine) or adulterated or impoverished milk or cream; condensed separated or skimmed milk. It is further provided by the 1907 Act that in the list of articles, importation of which is made an offence by the 1899 Act, there shall be included the following articles: butter containing more than 16 per cent of water; margarine containing more than 16 per cent of water or of 10 per cent of butter fat; milk-blended butter containing more than 24 per cent of water; milk-blended butter except in packages conspicuously marked with such name as may be approved by the Board of Agriculture; butter margarine or milk-blended butter which contains a preservative prohibited by any regulation under the Acts, or an amount of a preservative in excess of the limit allowed by such regulation. Margarine cannot be lawfully sold except under the name of margarine or a name combining the word margarine with a fancy or other descriptive name approved by the Board of Agriculture. Such name will not be approved if it refers to, or is suggestive of, butter or anything connected with the dairy interest. Similar regulations apply to the sale of milk-blended butter. Where margarine or margarine cheese is sold otherwise than by retail every package whether closed or open must be branded or durably marked 'margarine' or 'margarine cheese' as the case may require, on the top, bottom, and sides, in printed capital letters not less than $\frac{3}{4}$ in. square. The brand must be on the package itself and not merely on a label, ticket, or other thing attached thereto. All margarine cheese sold or dealt in otherwise than by retail shall either be enclosed in packages marked as aforesaid, or be itself conspicuously branded with the words 'margarine cheese'.

Where margarine or margarine cheese is exposed for sale by retail, there shall be attached to each parcel thereof so exposed, and in such manner as to be clearly visible to the purchaser, a label marked in printed capital letters [not] less than $1\frac{1}{2}$ in. square, 'margarine' or 'm[ar]garine cheese' as the case may require. In [the] absence of a label the article exposed is [pre]sumed to be sold as the genuine article. Wh[ere] any person sells margarine or margarine che[ese] by retail, except in a package durably mar[ked] as aforesaid, he shall deliver the same to [the] purchaser in a paper wrapper on which shal[l be] printed in capital block letters not less t[han] $\frac{1}{4}$ in. long and distinctly legible, 'margarine' [or] 'margarine cheese' as the case may require. [No] other printed matter shall appear on the wr[ap]per. What has just been said with regar[d to] the marking of wrappers, &c., used in con[nec]tion with margarine is subject to the pro[viso] that where the Board of Agriculture has [ap]proved of a fancy or other descriptive nam[e to] be used in combination with the word 'm[ar]garine' such other name may be printed on [the] wrapper, package, or label in type not la[rger] than and in the same colour as the word 'm[ar]garine'. Similar regulations apply to the [sale] of milk-blended butter, with the modifica[tion] that in any case where, in order to co[mply] with these conditions, the article is deliv[ered] to the purchaser in a wrapper, there shal[l, in] addition to the approved name, be printe[d on] the wrapper, in such manner as the Board [may ap]prove, such description of the article, setting [forth] the percentage of moisture or water conta[ined] therein, as may be approved by the Boar[d].

In the event of any prosecution for a co[ntra]vention of the provisions of the Acts the [pre]sumption is against the vendor. If, how[ever,] he can satisfy the Court that he purchased [the] article as genuine and got a written warr[anty] to that effect, that he had no reason to be[lieve] at the time he sold it that it was otherwise, [and] that he sold it in the same state as whe[n he] purchased it, he is entitled to be disch[arged] from the prosecution. See also under Foo[d and] Drugs Acts. [D.

Marigold. The Pot Marigold is desc[ribed] under Calendula, and the Corn Marigold u[nder] Chrysanthemum.

Maritime Pine. See Pine.

Marjoram, a plant cultivated for the [sake] of its leaves, which are of high value a[s an] aromatic for culinary and all general pur[poses]. See Origanum; also Herbs and Herb Indu[stry].

Market Gardening. See the artic[le on] this subject under the general heading Far[ming,] Systems of.

Market Gardens (in Law).—The [ten]ant of a holding cultivated wholly or main[ly for] the purpose of market gardening, in resp[ect of] which there is an agreement in writing [made] on or after Jan. 1, 1896, that it shall be [let or] treated as a market garden, may, under se[ction ...] of the Agricultural Holdings Act, 1908, a[t the] determination of the tenancy on quittin[g his] holding, in addition to the rights of comp[ensa]tion given to ordinary agricultural tenan[ts by] the same Act (see article on the Agricul[tural] Holdings Acts in Vol. I), obtain from the [land]lord compensation for the following imp[rove]ments made by him, viz.: (1) planting of [stan]dard or other fruit trees permanently se[t out];

(2) planting of fruit bushes permanently set out; (3) planting of strawberry plants; (4) planting of asparagus, rhubarb, and other vegetable crops which continue productive for two or more years; (5) erection or enlargement of buildings for the purpose of the trade or business of a market gardener. He is also entitled to compensation in respect of any such improvement which he has purchased from a former tenant, even although the landlord has not consented to the purchase, and he may remove all fruit trees and fruit bushes planted by him and not permanently set out; but if he does not remove such fruit trees and fruit bushes before the determination of the tenancy, they will remain the property of the landlord, and the tenant will not be entitled to any compensation in respect thereof. The term 'holding' has been held to include 'part of a holding' (see Callander *v.* Smith, 37 Sc. L.R. 890; 2 Fraser, 1140). In the case of a contract of tenancy current on Jan. 1, 1896, and still existent, if the holding was at that date in use or cultivation as a market garden with the knowledge of the landlord, and the tenant thereof had then executed thereon, without having received previously to the execution thereof any written notice of dissent by the landlord, any of the abovementioned improvements, the provisions of sect. 42 of the Act will apply in respect of that holding as if it had been agreed in writing after that date that the holding should be let or treated as a market garden, and so that the improvements in respect of which compensation is payable will include improvements executed before as well as improvements executed after that date; but where such a tenancy was a tenancy from year to year the compensation payable in respect of any such improvement will be such (if any) as could have been claimed if the Agricultural Holdings Act, 1908, had not been passed. [A. J. S.]

Marketing of Farm Produce — Weights and Measures employed. —There is probably no other country in the world in which sales of the products of the soil are conducted under such complicated methods as those which prevail in the United Kingdom. At various times during the last fifty years great efforts have been made to substitute uniformity in the sale of such products for the jumble of various weights, measures, and denominations existing, not only in different local markets, but also, to some extent, even in the great central markets. Mainly as the result of early efforts in this direction, the Weights and Measures Act of 1878 was passed. This was a consolidating measure, which repealed all earlier laws of its kind.

In its first operative section the Act bravely ordered that 'the same weights and measures shall be used throughout the United Kingdom'; but never was a provision of an Act of Parliament more thoroughly a dead letter. A penalty not exceeding forty shillings was imposed upon any person 'who sells by any denomination of weight or measure other than one of the imperial weights or measures, or some multiple or part thereof', and the publisher of any newspaper or price list quoting denominations of weights or measures differing from those defined in the Act was rendered liable to a fine of ten shillings for every copy. No one, however, appears to have paid any attention to the Act, so far as the denominations of local weights or measures were concerned. It is true that most of the local market quantities could be shown to be within the wide latitude allowed by the words 'or some multiple or part thereof'; but denominations not recognized by the Act continued in use. A notable example was the 'stone of 8 lb.' by which cattle and sheep were sold in the London market, dead weight, sinking the offal. The use of the term 'stone' for any other weight than 14 lb. was made illegal, and the publication of quotations per stone of 8 lb. also. Yet it has continued to be the sale unit in London as universally as ever, and newspapers have regularly quoted prices under that denomination without one of them having been fined for defying the law.

With respect to corn, it was apparently the intention of the authors of the Act to make its sale by the bushel or the quarter of 8 bus. uniform throughout Great Britain, and by the stone or hundredweight in Ireland. As to the latter country, this method of selling was common, if not universal, when the Act was passed; but in Great Britain sales of corn by various weights increased rather than diminished in prevalence. Indeed the tendency at the time was to sell more and more by weight, or by what is called 'weighed measure'. Immediately after the Act was passed, meetings were held in various parts of the country to discuss it, the result being the presentation of a memorial from the Central Chamber of Agriculture, and the National Association of British and Irish Millers, to the Board of Trade, asking for the legalization of the cental of 100 lb. This request was granted, an Order in Council legalizing the cental being issued a few weeks after the Act of 1878 came into force. But this only introduced a fresh complication, as the cental was adopted only in Liverpool and about half a dozen other markets. This was shown by a Parliamentary Return issued after the Act came into force, summarizing reports from inspectors of corn returns on the various measures and weights used in the sale of corn in the principal markets of England and Wales. They found that wheat, for example, was sold by measure only in 65 markets, by measure of a certain weight in 79, and by weight alone in only 12. The measures included the quarter of 8 imperial bushels, the coomb of 4 bus., the load of 5 qr., the boll of 2 bus., the Winchester bushel, the Carlisle bushel, the Appleby bushel, the bag, the listred, and the windle. In so-called measures of various weights, the range per quarter was from 470 to 600 lb., while a load of 280 lb. and a bag of 120 lb. to 125 lb. were local curiosities. Where weight only was in use, the stone, the hundredweight, and the cental only were named. In reality, however, sale by 'a measure of a certain weight' is not a sale by measure at all, as the commodity is not measured. The tendency in recent years

has been to adopt more and more generally the London standard of 504 lb. as the quarter of British wheat; but there is no approach to uniformity at present, and sales are often by the quarter of natural weight, which varies considerably. British barley is sold by measure or by 'weighed measure', and oats and pulse generally go by the latter. Foreign wheat in London is quoted by the quarter of 496, although much is imported per 480 lb. and per 492 lb. respectively. In Liverpool it is sold by the cental of 100 lb. Foreign barley and oats vary in weights per quarter with their several sources. Maize is quoted in London by the quarter of 480 lb.

For some years a measure known as the Corn Sales Bill, proposing to make the sale of all kinds of corn and flour and their by-products by the cental compulsory, was before Parliament, and there is no doubt that it would have been passed if it had not been for the opposition of a section of the farmers. Growers of good malting barley were specially opposed to it, as they contended that colour and texture would not realize their full value in sales by weight. There is no validity in this objection, as sellers and buyers, with practice, would find the valuation of quality in relation to weight as easy as in relation to measure. Other objectors preferred the hundredweight of 112 lb. as a standard for the sale of corn and other farm produce, as less upsetting to our system of weights than the cental. Another party desired the entire adoption of the metric system for sales of all commodities, now in use in nearly all European countries. Apart from the muddle of varying weights and measures, there is nothing to complain of in the system of marketing corn in the United Kingdom. It is sold as a rule by the producer to the corn merchant, the miller, the maltster, the distiller, or the consumer, and the profit taken when middlemen are concerned in a transaction is generally very small.

Horses, store cattle, sheep, pigs, and milch cows are sold at so much per head as a rule, though store cattle are occasionally disposed of by the hundredweight of live weight. Fat cattle are sold to dealers or butchers at so much per head, by the hundredweight of live weight, or by the stone of 8 lb. or 14 lb. dead weight, sinking the offal. Fat sheep and lambs are mostly disposed of by the pound or stone of dead weight, or at a price per head; and pigs by the stone or score of dead weight. Sales by live weight, universal in the United States, have made comparatively little progress in England, but more in Scotland. In many of the markets in which weighbridges are provided, however, animals are often weighed alive before they are sold at a certain price per head, or at a price per estimated dead weight. The practice of consigning stock of all kinds to the auction marts, now common in all considerable markets, has greatly increased in recent years. Wool is quoted by the pound or the tod of 28 lb.

Milk for the most part is consigned by dairy farmers to dairymen in towns, at a price per barn gallon of 17 pt. or per imperial gallon; but some producers who are near centres of consumption dispose of their milk by retail, the pint or quart. The margin between prices received by producers and those paid consumers is generally large, and there appe to be a good opening for co-operation am dairy farmers for the retail sale of their m Butter is sold by the pound or the hundr weight; and cheese by the pound, the impe hundredweight, or the so-called hundredwei of 120 lb. Cream is marketed by the pint the pound.

The sale of hay is by the load of 36 trusse 56 lb. or the ton, and that of straw by the l of 36 trusses of 36 lb. or the ton. Roots sold by the ton, or by the acre for feeding the land.

A great diversity of weights and measu prevails in the marketing of vegetables fruit. Potatoes usually go in large quanti by the ton, or in small quantities by the h dredweight, the sack of 3 bus., the bag of 2 b or the bushel of 56 lb.; but new potatoes are casionally marketed in handle baskets of sta weights or in half-bushels weighed or measu In some cases they are sold by the acre, buyer raising and marketing the crop. Vari green vegetables are sold by the dozen or do bunches, usually thirteen to the dozen, the t of 60, the score, the pad of various numb the bag of about 56 lb., the sieve (bushel half-sieve, the bundle or dozen bundles, and pot of various weights. At Evesham and s other markets most vegetables are dispose by the pot, which is 20 lb. for parsley, 40 for green peas, beans, or brussels sprouts, 6C for turnips, 64 lb. for onions, and 80 lb. artichokes. A further diversity is the sal beet, culinary turnips, carrots, parsnips, and kale by market gardeners near London by 'load' or 'half-load', denoting the content flat covered baskets. British tomatoes are n keted in half-sieves, pecks, and handle bask but are priced by the pound as a rule. S foreign tomatoes come in cases or trays of v ous weights, and are often quoted by the c British fruit of nearly all kinds is markete sieves, half-sieves, and pecks, sometimes sin filled, but more often weighed, while str berries, raspberries, and other soft fruit disposed of also in handle baskets or pun of varying weights. There is no fixed we for a sieve or half-sieve of apples or pear the filled measures differ in weight in rela to the varieties. A half-sieve of apples va from 20 to 24 lb., and a sieve from 40 to 48 Choice apples and pears are also sold by dozen, tastefully packed in small boxes. A h sieve of plums or gooseberries should w 28 lb., and one of currants or other soft f 24 lb. The pot is 63 lb. for gooseberries, rants, and cherries, 64 lb. for apples, and 72 for plums. Fruits sold in large quantitie jam makers are disposed of by the ton. An can and Canadian apples are marketed lar in barrels containing about 3 bus., the Cana being a little the larger. These fruits are qu by the barrel. But choice apples and pears f California, other parts of the United States, A tralia, and Tasmania come in cases of var

weights, of which 36 to 40 lb. are perhaps the most common. Grapes are marketed in various kinds of packages, but sold by the pound.

Apart from the intolerable muddle of weights and measures for the sale of culinary vegetables and fruits, the system of wholesale marketing is a thoroughly bad one. The grower, unless near enough to a town to dispose of his produce to consumers or to shopkeepers, consigns it to a salesman, who sells it on commission, and returns whatever price he pleases. The producer has no check whatever upon the salesman, but has to trust him blindly. He never knows from actual evidence whether he gets the price his particular lot of produce makes, or an average of the prices of many lots from different senders on the day of sale, or something less than either. However honourable many salesmen may be, 'there are rogues in all trades', and no set of traders should be allowed to possess the unchecked power of wronging their clients which commission salesmen have. Again, the system of distribution is bad from another point of view. Retailers of vegetables and fruit check the consumption by charging consumers two or three times as much as they pay, thus causing artificial gluts in the markets, and enabling themselves to go on buying at extremely low rates.

From the preceding statements it will be seen that there is a great need of a thorough reform of the system of marketing the produce of the farm, garden, and orchard. Uniformity of sale by imperial weight, measure, or number should be required by law, and regulations to prevent injustice to producers should be imposed. See also Weights and Measures. [W. E. B.]

Markets and Fairs.—According to the most authoritative dictionaries the word 'market' means a meeting place for purchase and sale; a public place for buying and selling. The word 'fair' has rather a wider significance, and may be extended to include a holiday time or fête. Both, however, have been used colloquially from time immemorial, not alone in Great Britain, as a descriptive term for meetings of persons intent on selling or buying live stock or goods. Occasionally in Scotland the word 'tryst' is also used with a similar meaning, although when this is done it is in general specially identified with live-stock markets. Thus there are the Doune trysts in Perthshire, the Falkirk trysts in Stirlingshire, and the Georgemas trysts in Caithness-shire, live animals being the feature in each case. The origin of markets or fairs is obviously to be traced to the convenience of bringing together at stated times the buyers and sellers of the staple products of a district. In Europe the numerous festivals of the Church afforded the most favourable opportunity for the establishment of these markets. This association is indicated in the German name of a fair, which is identical with that used for the ceremony of the Mass.

In the early days of civilization fairs were of great importance, and were frequently privileged and chartered by princes and magistrates, public proclamation being made of their commencement and duration. But modern facilities for travel and communication, and the establishment, especially in Great Britain, of the system of selling both live stock, and goods by auction, have led to a great reduction in the number of fairs held. However, the plan of holding fairs for the purchase and sale of goods (including animals) has not wholly died out. A good many are still held in Europe, the most important being those at Leipzig and Frankfort-on-the-Main in Germany, at Lyons in France, and Nijni-Novgorod in Russia. The last-named is believed to be the largest fair in the world. It extends over about a fortnight, and is attended by merchants, traders, and others from all parts of Europe, and to a limited extent also from Asia. Dealers even from Great Britain sometimes visit Nijni-Novgorod fair in search of horses and ponies. In Great Britain fairs now mostly consist of the weekly market days of country towns, and half-yearly or yearly markets for the hire of farm servants. Even the latter are rapidly declining in interest and importance through the establishment of registry offices, and the growing custom of making engagements through the medium of newspaper advertisement.

Of the live-stock fairs still left in Scotland, perhaps the most important is the Inverness Sheep and Wool Fair. This fair has been held for a great many years, opening usually on the second Thursday in July. A feature of this fair is that no stock are shown; the bulk of the business is transacted in one or other of the hotels, where the buyers and sellers meet together on Thursday and talk over matters, and make bargains during that and the two following days, by which time the whole business must be wound up. The seller reports what is the condition of his sheep compared with the former year, and the bargain is then made according to the seller's report and the existing state of the general markets. Should the seller affirm that his sheep are one shilling per head or more better than the previous year, and the market be the same as to prices, the seller obtains the relative advance. On the other hand, should the market value of sheep be a shilling less than the previous year, the seller has to accept the reduction, unless he can prove to the satisfaction of the buyer that the sheep are better by such an amount, in which case, although the general market be lower, he would get a similar price to that year. In this way improvement of the stock is sometimes made to compensate for depreciation of the markets.

Wool at Inverness is dealt with on somewhat similar lines; and although enormous sums are turned over in this way, it is a tribute to the long-sustained confidence which exists between buyers and sellers, that hardly ever a case has come into the Courts over a disputed transaction at the Wool Fair. Deliveries of sheep and lambs bought at the Inverness Fair are made usually during the ensuing month. The sheep go straight to their new owners from their grazings, and are thus saved the harassing and depreciatory effect of being driven from market to market. A somewhat similar fair, but on a much smaller scale, takes place at Oban.

Amongst the larger fairs in Scotland at which stock are shown may be mentioned All-Hallow Fair, Edinburgh, held in November (horses and store cattle); Trinity Muir Fair, near Brechin, held in June, principally for horses; St. James's Fair, Kelso, held in August, now also largely confined to horses; and the Doune, Falkirk, and Georgemas trysts already referred to. The last is mainly a sheep market; the other two include cattle as well as sheep, although of late years the entries of either have not been a tithe of what they formerly were. Indeed some of both the Doune and Falkirk markets have passed without any stock being shown. Glasgow Fair, so important in the old days, now exists practically only in name as a holiday; and such important old fairs as those at St. Boswells, Melrose, and West Linton have also ceased to exist, at least under the old conditions, the competition of the auction marts having proved too much for them.

A somewhat similar tale has to be told in regard to England. While there are still as in Scotland a number of centres at which private selling is carried on—Newcastle Market and the Metropolitan Market at Islington, London, are prominent examples—the most of the old big fairs have ceased to exist, their places having been taken either by small weekly markets in the district towns or by auction sales. This of course only applies so far as cattle, sheep, and pigs are concerned. Grain in both England and Scotland is still sold in the old way by private treaty, most country towns having now covered exchanges for this purpose. These exchanges are also taken advantage of by seed, manure, and cake merchants, so that the farmer can both sell what he has got to sell in the way of grain, turnips, and potatoes, and buy what he requires to buy in the way of manures, cake, or seeds, with a minimum of trouble or exertion. Moreover most of the trading agents are represented at the auction sales, so that the farmer has a double opportunity of satisfying his wants. The modern system of selling has no doubt shorn the old marketing arrangements of much of their picturesqueness and sentiment, but on the other hand it has led to a great economizing of time and a marked conservation of physical energy.

Although auction marts are also making considerable headway in Ireland, there are still a good many fairs there, principally for the sale of store cattle. These are attended by all the leading dealers, who buy up the animals from the small owners in twos and threes, and then ship them in considerable lots to the English and Scottish sales or markets. At most of the markets and sales in England, Scotland, and Ireland the system of selling cattle, sheep, and pigs is mainly at so much per head, although of late years an attempt has been made in some cases to buy and sell cattle, at any rate, on a basis of live weight. When this is the case, the buyer usually tries to buy lean cattle at as nearly 10*s.* per live cwt. under the prevailing price of fat cattle as he can. Otherwise he has to face the probability of having to go without much profit for his feeding operations. Grain is nearly always sold on a basis of weight, sometimes at so much per bushel, but mainly at so mu per quarter of a given weight. [A. S. G.]

Markets and Fairs (in Law).—T custom of holding markets and fairs is of gr antiquity, and they have long been held throug out Europe and in many parts of Asia. England there were already many in existe at the time of Domesday. In Europe they w originally associated with the Church festiv as is clearly indicated by the derivation of word 'fair', which comes from the Latin *fer* meaning festivals. The German word for fair, *messe* (mass), points to the same orig and the use of the word 'mass' as meani a Church festival is shown in such words Candlemas, Lammas, &c. It has been said t 'every fair is a market, but every market not a fair'. The main distinction briefly that a fair is held once a year or at least long intervals, while a market is held weel or at short intervals. No proper market exist without a grant—originally obtained fr the Crown—or by prescription, which presu poses such a grant as its foundation. 'T reason why a fair or market cannot be oth wise claimed is not merely for the sake of p moting traffic and commerce, but also for like reason as in Roman Law, for the preser tion of order and prevention of irregular haviour.' Consequently in every fair or marl so constituted there was held a court, which l jurisdiction in all civil questions arising fr the transactions entered into thereat. Th courts, known as Courts of Piepowder ((French *pied pouldre*, from the dusty feet the litigants), have now practically ceased exist.

Authority to construct or regulate a marl or fair is now conferred by special Act of Parl ment; and in order to avoid the necessity repeating the provisions usually contained each of the several Acts, as well as to ens uniformity in them, a consolidating Act v passed in 1847—the Markets and Fairs Clau Act, 1847. By that Act ten days' notice must given by advertisement of the opening of a market or fair. After the marketplace is open any person other than a licensed hawker w shall sell or expose for sale in any place wit the prescribed limits, except in his own dwelli place or shop, any articles in respect whe tolls are authorized to be taken in the mark shall be liable to a penalty. Penalties are a imposed for selling or exposing for sale u wholesome meat, &c., or for obstructing an spector or the market keeper. Power is gi to erect slaughter-houses if authorized by special Act, and penalties are imposed on a one slaughtering cattle, &c., elsewhere than the authorized slaughter-house, except in slaughter-house which was in use as such bef and at the time of the passing of the spec Act and has so continued ever since.

Proper accommodation must be provided the weighing of commodities or carts laden w goods, which must be weighed if so desired the purchaser, and penalties are imposed sellers of goods or drivers of carts for refus Provision is made for levying, varying, and

covery of rents and tolls. Power is conferred on the market authority to make by-laws for regulating the use of the marketplace, &c.; for fixing the duration of the market; for inspection of slaughter-houses, &c., and keeping same clean; for regulating the carriers resorting to the market, and fixing rates for carrying articles carried therefrom within the limits of the special Act; for regulating the use of the weighing machines and preventing the use of false or defective weights, measures, or scales; and for preventing the sale or exposure of unwholesome provisions.

In order to afford the like facilities for weighing cattle in markets and fairs as are afforded for weighing goods and carts under the Act just referred to, the Markets and Fairs (Weighing of Cattle) Act, 1887, as amended by the Markets and Fairs (Weighing of Cattle) Act, 1891, provides that in or near every market or fair in which tolls are for the time being authorized to be taken and actually are taken in respect of cattle (including sheep or swine), the market authorities shall provide and maintain to the satisfaction of the Board of Agriculture sufficient accommodation for weighing cattle, and the weighing machines must be tested at least twice a year by the local inspector of weights and measures at the cost of the market authorities. An auctioneer, unless exempted by order of the Board of Agriculture, may not sell cattle at any mart where cattle are habitually or periodically sold, unless such facilities for weighing cattle are provided. Provision is made for the return by the market authority of any market held in any of the places mentioned in the Schedule to the Act of 1891, as varied by the Markets and Fairs (Weighing of Cattle) Order of 1905, and by auctioneers selling in such markets, of statistics as to the number and weight of the cattle weighed, and the price of those sold thereat. These returns are to be published by the Board of Agriculture in such manner as they think most expedient for the information of the public. Further provisions as to the necessary returns are made by the Order of 1905 above referred to.

In virtue of the powers conferred on them by the Diseases of Animals Acts, 1894 and 1896, the Board of Agriculture have issued the Markets and Sales Orders of 1903 and 1904, whereby it is ordered that—

(1) A market or sale of animals shall not be held in or upon any marketplace, highway, sale yard or other premises, until after the expiration of eight days from the date on which the premises were previously so used, unless the premises, or a part thereof sufficient to accommodate the number of animals usually exposed at such market or sale, are so paved with cement, concrete, asphalt, or other hard material impervious to water, as to permit of the same being effectually cleansed by washing.

(2) This Article shall not be deemed to prohibit the holding of any lawful fair on two or more consecutive days.

Provision is also made for the cleansing and disinfection of marketplaces, sale yards, and other places where sales are habitually held, as soon as practicable after use, and before being again so used.

By the Fairs Act, 1871 (applicable to England and Wales only), power was conferred on the Home Secretary to order a fair to be abolished on representation of magistrates with consent of owner. For the purposes of the Act 'owner' means any person, body of commissioners, or body corporate entitled to hold a fair. By the Fairs Act, 1873 (applicable to England and Wales only), the Home Secretary has power to alter the dates of holding fairs.

Generally speaking, when goods are sold by a person who is not the true owner, and who is not selling by instructions of or under authority from the true owner, the purchaser acquires no better title to them than the seller has. But by the Sale of Goods Act, 1893, it is enacted that—

(1) Where goods are sold in market overt, according to the usage of the market, the buyer acquires a good title to the goods, provided he buys them in good faith and without notice of any defect or want of title on the part of the seller.

(2) Nothing in this section shall affect the law relating to the sale of horses.

(3) The provisions of this section do not apply to Scotland.

It will be observed that the section just quoted does not affect the law relating to the sale of horses. According to the law of England, in order to acquire a good title to a horse which has been stolen the formalities prescribed by the Statutes 2 & 3 Phil. & Mary, c. 7 (1555), and 31 Eliz., c. 12 (1589), must be observed. They are as follows: The horse must be openly exposed in the place appointed in the market for the sale of horses for one whole hour together between 10 a.m. and sunset. If sold, the buyer and seller must attend with the horse on the bookkeeper of the market and get him to enter in his book the price, colour, and marks of the horse, with the addresses of buyer and seller, the latter address being properly attested if not known to the bookkeeper of his own knowledge. In spite of the observance of all these formalities the true owner of a stolen horse may, within six months of the theft, reclaim his property on tendering to the person in possession such price as he paid in good faith in market overt. In Scotland the law is that the true owner of stolen goods may recover them from third parties who have purchased them, although in good faith; but if one who has purchased goods in public market has in good faith disposed of the goods to another before they are claimed, he will not be bound to restore to the true owner the price received except to the extent of any excess over the price he paid.

The sale of hay and straw in London, Westminster, or within thirty miles thereof, is regulated by the provisions of the Hay and Straw Acts, 1796, 1834, and 1856. [D. B.]

Markham, Gervase (1568–1637), one of the most prolific writers on agricultural affairs whom the 17th century produced. The scion of a distinguished family, he was born on his father's estate at Cottam in Nottinghamshire

and the excellent education which he received in his early youth is reflected in that remarkable literary career which made him famous, not only as an authority on agriculture, but also as a poet and scholar. In his early manhood he bore a commission in the army, and there is no doubt that his active service abroad made him a keen student of nature and extended his knowledge beyond the somewhat narrow domain of British agriculture. On his return to England he turned to literature for a subsistence. His published works show the breadth of his accomplishments; the dedications of many of his books exhibit him as a courtier, the substance of his writings stamp him as a practical husbandman, an authority on horses and horse-breeding, and a master in the realm of sport. He was the owner of a valuable stud of horses, and is said to have been the first to introduce Arab horses into Britain. His contributions to the agricultural literature of the day were long remembered, and are specially noted by Walter Blith in his English Improver. As a writer Markham was exceedingly industrious, and as a compiler for booksellers on an extensive scale he won the name of 'the earliest English Hackney writer'. Many of his earlier works on husbandry are merely the revised versions of books written by previous writers. Nor did he scruple to repeat himself, for he published several works on the same subject, giving each a different title. Such flagrant repetition caused contentions among the booksellers in regard to his published works, till at last the latter for their own protection obtained his signature to a paper in which 'Gervase Markham of London, Gent', promised to write no more books 'on the diseases of any cattle, horse, ox, or cow, sheep, swine, or goats'. The best known of his agricultural works are: How to Chuse, Ride, Traine, and Dyet both Hunting Horses and Running Horses; Cavelarice, or the English Horseman; The Husbandman's Faithfull Orchard; Cheape and Good Husbandry; Maison Rustique, or the Country Farme; Markham's Maister Peece; The English Husbandman; Markham's Farewell to Husbandry. He was also the author of tragedies, comedies, and various poems. [R. H. L.]

Markhor, or **Markhoor** (*Capra falconeri*), a large species of wild goat, with spirally twisted horns, which occurs in Kashmir and mountainous districts in Afghanistan and northern Baluchistan. The colour of the short summer coat is a tolerably uniform yellow-brown, but towards the winter, especially in the males, the hair, which has only a small amount of underwool, becomes longer and shaggy, and gradually turns grey or dirty-white over the body, though remaining short and browner on the head, legs, and hind quarters nearly up to the root of the tail; the tail is black, and the legs whitish with dark markings in front below the knees and hocks. The male has a well-developed black beard, a crest of hairs running along the throat to the breast, and a mane over the neck and shoulders; the long hairs forming the mane and crest are wanting in the females, and the beard is either small or absent in this sex, which is in addition very much smaller than the male, and has horns only a few inches in length, though spirally turned. The male stands about 38 i or more at the shoulder, and the horns common measure over 4 ft. round the curve, and over 3 in a straight line. They differ, however, in sha to an extent not met with in any other speci of hollow-horned ruminant, the curvature the spiral being close like that of a gimlet, wi many turns, or open like that of a corkscre with few turns. In some cases, also, they strete upwards close together; in other cases they c verge greatly, their points being widely sep rated. In the young animal the horn rises fro the head like that of an ibex, and is lateral compressed with an anterior and a posteri ridge; but when a few inches long the anteri crest begins to turn outwards and the posteri crest inwards, the latter soon appearing on tl front of the horn and the former on the bac The anterior crest gradually becomes less pr nounced as age advances, the dominant crest i the lower half of the horn in the adult bein the posterior one which has been twisted int an anterior position. The shape of the horr does not, however, vary to any great extent i one locality, and geographical races of the Ma khor have been established upon the shape the horns. Horns with gimlet-like twist a found in Markhor ranging from the Punja into Afghanistan and Baluchistan; while thos exhibiting the most open corkscrew-like twi occur in Kashmir and Baltistan. Every grad tion, however, appears to be traceable betwee these two extremes.

Owing to the scantiness or absence of th underwool, the Markhor is more susceptible t cold than other species of goats, and is foun therefore at lower elevations, and commonly nc above the level of forests. It is well known tha domestic goats frequently exhibit a spiral twis in their horns, and it has been suggested tha this may be due to descent from the Markhor But European domestic goats have all the char acters of the wild Ibex (*Capra ægagrus*) of Asi Minor, Greece, and Persia, and the twist in th horns, when present, takes an opposite directio from that of the Markhor, the anterior cres turning inwards instead of outwards. In th Circassian breed, it is true, the spiral twist i in the same direction as that of the Markhor nevertheless it seems probable that this variety is descended from the same wild stock as ou own and other domestic breeds. [R. I. P.]

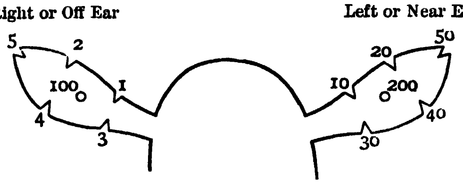
Marking Cattle and Sheep.—Use o distinctive marks to indicate ownership of farn stock is of unknown antiquity. A Highlan tradition has it that all the native cattle wer ear-marked as a matter of necessity before bein sent to common grazing on the hills. On Ameri can and other ranches, branding of cattle ha been resorted to for the purpose of keeping th stocks in correct form for reckoning. In en closed and settled countries, branding of th more valuable stocks of pure-bred cattle on th hide is now little favoured. Horn stamping and ear punching or notching are coming mor into favour. Branding of the hide is certainly a most effective method of marking, but com mercially it is faulty.

Marking of cattle is not a regular necessity

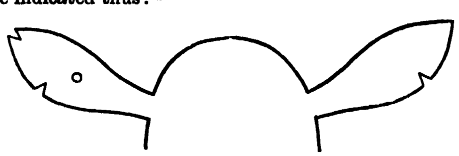
in this country, but in the interests of accuracy in checking pedigrees it might be more generally practised. Horns are good foundation agents for marking in the case of many breeds of cattle and several breeds of sheep, as carefully burnt marks or letters on such surfaces are indelible. The cruel Highland practice of using the hot-iron mark on the ridge of the sheep's nose is now happily almost out of date. For ease and rapidity of manipulation the ears of animals are favourite subjects with markers. In the case of sheep the further aids of tarring or buisting and keeling certain parts of the frame are useful, especially after clipping or as preparation for change of quarters. On the ears the marker can practise (1) by notching, punching, and slitting; (2) by tattooing; or (3) by fixing metal studs or the so-termed ribbon and lock-ear tags. The first-named method is the oldest, and the likelihood is that it will hold its own for hill flocks. In recent years registers of marks used for certain hill-sheep stocks have been published, for the purpose of tracing stolen or strayed animals. One of the clearest of those publications is that for Lanarkshire and parts of the counties adjoining it.

A numbered system of notching and punching is very useful for owners of cattle and low-ground flocks. This system is simplicity itself. A diagram will make it clear.

Right or Off Ear | Left or Near Ear



The above illustration indicates the total notches and the two punches along with the numerical values. In the case of such a number as 31, the low inner notch on the near ear and the high inner notch on the off ear would suffice. The number 149, for example, would be indicated thus:—



In the private register the breeding ewes are numbered in plain figures right onward with the breeding of sire and dam. A glance at the ear marks then puts individuality into the system. Shepherds and owners who do not keep full pedigrees generally nip the ears of special animals in order to check the progeny of certain sires. Thus a 'near fore-bit' or an 'off back-bit'—a nip on the upper edge of the left ear, or the like on the lower edge of the right ear—will suffice for grouping the progeny of two rams.

Tattooing inside a white ear with a black or blue preparation, and in the case of a dark ear with a reddish stamp, may be classed as modern. In Border Leicesters the registered flock number is given in one ear, and the letter and number indicating breeding of the animal are recorded in the other. Studs, ribbon markers, and lock-ear tags are very convenient in the case of export stock, but for field wear where hedges and fences are in touch the two first noted are apt to be torn out. It is claimed for the lock-ear tag that the wearing causes no irritation, but cattle will put the best of the metal devices in danger when they start to comb and brush their heads and ears, especially in spring. Sheep are much more patient. [J. CA.]

Marking-nut (*Semecarpus Anacardium*, Linn., nat. ord. Anacardiaceæ), a deciduous tree of the sub-Himalayan tract and also of the hotter parts of India. The pericarp of the unripe fruit contains a bitter and powerfully astringent principle universally used in India as a marking-ink. For this purpose it is mixed with lime water to act as the mordant, and hence the mark made becomes indelible, as it is insoluble except in alcohol. It is, in fact, a far more durable and less injurious marking-ink than most of the preparations of that nature used in Europe, since it simply dyes and does not burn the textures.

On tapping the stem an acrid viscid juice is obtained, which is largely used as a natural varnish. The fleshy cup on which the fruit (nut) is borne is edible, as also the kernel of the nut itself. From the kernel may be prepared a sweet oil. [G. W.]

Marl and Marling.—Geologists have applied the term 'marl' to any soft calcareous clay rock, without having much regard to the proportion of carbonate of lime which it contains. If the rock is indurated it is called *Marlstone*—a name originally given by Wm. Smith to the marl of the Middle Lias; and if it is also laminated it is known as *Calcareous Shale*. The best-known examples of marl deposits in Britain are those of the Middle Lias, the 'Malm' and Chalk Marl of the Cretaceous System, and the New Red Marl of the Trias. A not inconsiderable portion of the earth's surface is occupied by marls which were originally deposited at the bottoms of freshwater lakes, and which represent the remains of freshwater algæ, the shells of snails and crustaceans, and other organic debris. The marls of these old lake-basins, as those of Miocene age in Auvergne and Switzerland, and those of Eocene age in Wyoming, cover areas hundreds of square miles in extent, and attain a thickness of many hundreds or even thousands of feet (Geikie, Textbook of Geology, 4th ed., vol. i, p. 525). Similar 'shell marls', consisting almost entirely of calcium carbonate, are also found as deposits underlying peat bogs, as in central Ireland, having been formed in the way above described, at the bottoms of the shallow lakes in which the peat bogs originated.

All these calcareous rocks crumble to pieces on exposure to the air, and give rise to easily worked friable soils of high fertility. In the strict agricultural sense the term 'marl' is applied only to a clay containing from 5 to 20 per cent of carbonate of lime, but still retaining all the plastic characters associated with a true clay. The term is unfortunately often misapplied by farmers to any fine-grained earth which crumbles

easily under atmospheric conditions, and which is free to work like a true marl, even though it may be utterly destitute of lime.

Marl is frequently used as a source of lime for topdressing land that is in need of that ingredient. The cost of carting necessarily limits its use to the immediate neighbourhood of the beds where it is found. It is of greatest benefit as an amendment for sandy soils, on which its clayey basis acts as a valuable textural corrective.

[It is interesting to note that the town of Castle Douglas in Kirkcudbrightshire practically owes its foundation to the marl dredged from the adjacent Carlingwark Loch, the trade in which was the first cause of its prosperity.] [T. H.]

Marling is described by Pliny as one of the ancient British agricultural practices, even the word 'marl' is said by him to be the original British name ('Quod genus terræ Galli et Britanni *margam* vocant', xvii, 7). Every agricultural writer since his time mentions it, and there are frequent references to it in the Middle Ages. Leases are still on record from the time of Edwards I and II requiring tenants to marl their land. Fitzgerald (The Book of Husbandry, 1523) strongly advocates it. Bernard Palissy (Discours admirables, 1580) has a long treatise on marl, which he describes as 'vn fumier naturel et diuin, ennemi de toutes plantes qui viennent d'elles mesmes, et generatiue de toutes semences qui ont esté mises par les laboureurs'. Gervase Markham (The Inrichment of the Weald of Kent, 1625) says: 'Howsoeuer this Weald be of itselfe vnfruitfull and of a barren nature, yet so it hath pleased the prouidence of the Almighty to temper the same, that by the benefit of Margle or Marle (as it is commonly called), it may be made not only equall in fertility with the other grounds of the shire, as well for corne as grasse, but also superior to the more and greater part of the same'. Several proverbs relating to marling are recorded by the old writers, thus 'a man doth sand for himselfe, lyme for his sonne, and marle for his grandchilde' shows that the improvement was permanent, and no doubt has reference to light land; another that 'lime and marl are good for the father but bad for the son' would hold true on heavier land if marl was the only manure used. In the south-eastern counties and in the Midlands a number of the fields and lanes were called on old estate maps 'Marl Pit field' and 'Marl Pit lane', and many of these names still survive.

In a general way the old writers knew the difference between chalk and marl, but they could not always discriminate between marl and impure clays; indeed Palissy expressly states that the marl must be tried in small quantities before it is applied on the large scale; the same advice is given by Sir Hugh Plat in 1653 (The Jewel House of Art and Nature). It is certain that much of the so-called marl used in the Weald was not marl at all, and must have been worthless as manure. Not till Black discovered the composition of chalk in the middle of the 18th century could any definite chemical test be applied. He found that good marls, in virtue of the chalk they contained, gave off carbonic acid on treatment with acids, and from that time agriculturists were able to detect a marl at once by observing whether it effervesced on treatmen with hydrochloric acid. Thus we find Marshal in the travels (1780) continually applying this test

The early volumes of the Royal Agricultura Society's Journal (1840 onwards) contain severa papers on marling. 'I need not', says Puse (1850, vol. xi, p. 407), 'describe the effect o marling a blowing sand. The finest exampl I have seen is on the Duke of Bedford's hom farm at Woburn, where in consequence th old parish turbary is waving with corn. Th glories of Holkham, too, once a sandy waste rest on this foundation of clay.' He goes o to quote cases in Lincolnshire, Lancashire, an Somersetshire where large areas of peaty lan have been reclaimed by marling. The metho adopted on sandy land at Woburn and in Nor folk (see Journal of the Royal Agricultur Society, vol. iii, 1842, p. 233; also vol. v, p. 30 was to apply about 40 loads per acre on clove leys directly the crop is off, or on turnip fa lows early in winter; the marl could then be come broken up by the winter and spring frost before being ploughed in. Peaty soils receive about 80 loads per acre. The cost of the labou at Woburn is given at 3*d.* a load, *i.e.* about 10 per acre where the marl was on the spot an simply required carting and spreading; where had to be got from a distance the cost was muc greater. An interesting description is given i vol. xxv of the Journal of the Royal Agricultur Society (1864, p. 369) of the method adopte for reclaiming Delamere Forest, Cheshire, wit full details of cost. The soil was light sand ar gravel, with patches of peat; the marl had be found, and conveyed by a tramway special laid down. The total cost for marling one far of 248 ac., giving on the average 117 yd. to t acre (the actual amounts varied from 100 180 yd.), worked out to £7, 5*s.* per acre; but t land, which before marling was not worth 5*s.* p acre, was then let at £1, 10*s.* per acre. Anoth farm of 800 ac. cost £9, 18*s.* per acre to marl the same rate, and its value rose in consequen from 5*s.* to £1, 12*s.* 6*d.* per acre. In the Ne Forest a royalty of 6*d.* a ton had to be paid f marl, and the cost was put at £8 per acre f a dressing of 70 tons (Journal of the Roy Agricultural Society, vol. vii, 1871, p. 25 The most striking effects were obtained on lig sands deficient both in clay and chalk; heav soils only benefited when the marl contain a good deal of chalk.

The effect was permanent. Instances are corded in Cheshire where marl lasted over six years (see Journal of the Royal Agricultu Society, 1864, p. 379); but this was not t universal experience, as compensation to o going tenants who had marled land was in L colnshire often paid on the assumption that t improvement lasted seven years only. Marli is now largely discontinued in Great Britain an agricultural practice, though it is not commonn in horticulture, for improving cric pitches, &c.

Marl is a mixture of clay and chalk, but

relative proportions vary enormously, the calcium carbonate ranging from 3 to 80 per cent. The best-known marls are—(1) those lying at the base of the Chalk throughout Kent, Surrey, Sussex, Hampshire, Wiltshire, Dorsetshire, and thence up through Bedfordshire to Norfolk and Suffolk; (2) the oolitic marls, much used in Lincolnshire; (3) the Keuper marls of Somersetshire, Devonshire, Cheshire, Nottinghamshire Leicestershire, &c.; (4) marls found under bogs mosses, and at the bottom of lakes. A few analyses are given below:—

	Grey Marl at Base of Chalk, Farnham.	Chalk Marl, Farnham.	New Forest.	Keuper Marl, Bridgewater.	Keuper Marl, Wainlode, River Severn.			Keuper Marl, Nottinghamshire.
	1.	2	3.	4.	5.	6	7	8.
Lime	43·23	49·16	13·75	1·44	4·92	7·37	5·18	6·25
Magnesia	·30	1·18	1·12	·92	4·77	6·10	5·42	2·33
Ferric oxide ..					4·96	·87	3·80	
Ferrous oxide ...	4·89	3·36	10·66	8·82	·61	·96	·91	6·24
Alumina				6·67	—	13·12	12·98	11·10
Potash	·26	·11	1·04	1·48	—	—	—	1·44
Soda	1·64	1·36		1·08	—	—	—	—
Carbonic acid ...	29·96	36·73	12·47	2·87	9·61	13·01	10·21	2·2
Phosphoric acid .	·21	·05	trace	·51	—	—	—	0·145

No. 1 highly valued as manure, No. 2 not so good (Payne and Way, J R.A S.); Nos 3 and 4, A. Voelcker in Morton's Encyclopedia, art MARL; Nos. 5, 6, 7, analysed by Moody (Quart. J. Geol. Soc. 1905, 61, 431); No 8, a marl much used for cricket pitches, analysed by the writer.

The mechanical analysis of No. 8 was found to be:—

Gravel.	Coarse Sand	Fine Sand.	Silt.	Fine Silt.	Clay
·02	·42	7·16	14·25	17·24	35·63

A number of analyses of marls from Tübingen are given in Jahresbericht über Agrikulturchemie, 1901, p. 29. [E. J. R.]

Marl Grass is a common name applied to zigzag clover (*Trifolium medium*). It is sometimes called Cow Grass, but is readily distinguished from Red Clover and the Cow Grass of commerce by the pointed narrow green stipules at the base of the leaf-stalk, by the narrow darker-green leaflets of the leaf-blade, as well as by the brighter and richer purple colour of the loose flower-heads. This clover grows naturally in large patches on very dry banks and on waste ground, from a creeping underground stem, and, like most plants with this habit of growth, is very shy to produce seed. For agricultural purposes Marl Grass is worthless, since stock refuse to browse it unless compelled by hunger. On account of perennial character and power of withstanding extreme drought this is a useful plant for covering railway embankments and bare dry places with green vegetation. The seed is not an article of commerce, hence transplants from wild stocks are used for propagation; these transplants rapidly extend, and take possession of the bare ground. [A. N. M'A.]

Marram Grass, also called Maram, Sea Mat Grass, and Sea Reed, is an extremely useful sand-binding grass. See PSAMMA.

Marshall, William (1748–1818). — Marshall, who was a contemporary of Arthur Young, was born in the North Riding of Yorkshire, and came of a family who, it was his proud boast, were connected with the soil for over 400 years. Yet Marshall himself was apprenticed as a youth to commerce, and resided for fourteen years in the West Indies as a planter. Through failing health he was forced to return to England in 1775, whereupon he undertook the management of a farm in Surrey. There he wrote his first work, Minutes of Agriculture made on a Farm of 300 acres, of various soils, near Croydon, Surrey. In 1780 he acted as an estate agent in Norfolk, a position he held for four years During this time he contributed to the Philosophical Transactions 'An Account of the Black Canker Caterpillar which destroys the Turnips in Norfolk'—one of the earliest contributions to economic entomology. He subsequently resided in Stafford and in London, and finally he retired to the vale of Cleveland in his native county, where he purchased a considerable estate. His chief publication is A General Survey of the Rural Economy of England, in which he reviews the agricultural conditions and practices of the various counties of England. In a part of this work he advocated the establishment of a Board of Agriculture, a proposal which was carried into effect by Parliament in 1793. Though urged to take part in the work of the Board Marshall declined, but in his latter years he issued a review and complete abstract of the reports of this body. In 1804 he published An Elementary and Practical Treatise on the Landed Property of England. This was followed by a Treatise on the Management of Landed Estates, in 1806. An interesting work entitled Proposals for a Rural Institute or College of Agriculture and other Branches of Rural Economy appeared from his pen in 1799; and it was while raising such a building at Pickering that he died in 1818. [R. H. L.]

Marsh and Bog Plants. — In Great Britain and Ireland much of the land is marsh and bog. Such land produces plants of certain species, some of which are useful as fodder, for example 'Draw Moss' (*Eriophorum vaginatum*), and 'Sprot' Rushes (*Juncus acutiflorus* and *lamprocarpus*); other species are useful as litter straw, for example Water Meadow Grass (*Poa aquatica*). The great point is that the

vegetation of marsh and bog is rarely well utilized; much of the edible vegetation remains uneaten because of the inadequate number of stock put on at the proper season, much of the vegetation that could be cut for hay is allowed to wither and go to waste, and many plants that form excellent straw for litter are put to no useful purpose. This article on marsh and bog plants would be much too long if we were to enter into all the species, accordingly attention is confined to Rushes, Sedges, and Grasses.

The first point is to distinguish clearly between marsh and bog; although many plants are common to both, still there are many confined almost exclusively to marsh, and many others to bog. Further, when such lands are reclaimed, the manurial treatment and the most suitable plants to grow are different for the reclaimed marsh and for the reclaimed bog. Distinction is easy, if we take a broad view of the way in which soils originate. In certain cases the soil has been made from broken-down rocks, sand and clay for example—this is pure mineral soil. In other cases the material concerned is of vegetable origin, peat for example—this is vegetable soil, composed of the dead bodies of plants more or less decayed. Water, again, has its part to play. It enters into the pores of mineral soil to varying degrees, giving us the rough names dry, humid, moist, damp, and wet. Wet mineral soil with the pores full of water is *Marsh*. In the same way, water enters into the vegetable soil, not only filling the pores, but saturating the vegetable matter to varying degrees, giving us over again the names dry, humid, moist, damp, and wet. Wet vegetable soil saturated and filled with water is *Bog*. Bog soil is black, because decayed vegetable matter yields black-coloured compounds; but the Bog Moss (Sphagnum) growing on the surface sometimes assumes a characteristic red tint, under circumstances significant of unproductiveness, and accordingly inferior bogs covered with the red Sphagnum have the special name Red Bogs or Peat Mosses, to distinguish from Black Bogs, which yield better plants and do not produce the red Sphagnum.

Since marsh may pass gradually into soil only damp, the marsh plants include species found occasionally on soil only damp, and the same applies to bog. Again, marsh may pass into water-covered soil, and bog into spongy bog, bog hole, or submerged bog, and so again the marsh and bog plants include other species capable of growing more or less submerged in the water.

To distinguish marsh from bog by the vegetation, we require a list of those plants that are confined almost exclusively to marsh, and another list of those confined to bog. The marsh indicators are:—

RUSHES (*Juncaceæ*)—

- Blunt-flowered Jointed Rush (*Juncus obtusiflorus*).
- Sharp-flowered Jointed Rush or 'Sprot' (*Juncus acutiflorus*).
- Shining-fruited Rush or 'Sprot' (*Juncus lamprocarpus*).
- Hard Rush (*Juncus glaucus*).
- Toad Rush (*Juncus bufonius*).

SEDGES (*Cyperaceæ*)—

- Draw Moss (*Eriophorum vaginatum*).
- Creeping Spike Rush (*Eleocharis palustris*).
- Lake Club Rush (*Scirpus lacustris*).
- Wood Club Rush (*Scirpus sylvaticus*).
- Great Sedge (*Carex vulpina*).
- Great Panicled Sedge (*Carex paniculata*).
- Slender-spiked Sedge (*Carex acuta*).
- Carnation Grass (*Carex panicea*).
- Glaucous Heath Sedge (*Carex glauca*).
- Short-beaked Bladder Sedge (*Carex vesicaria*).
- Great Common Sedge (*Carex riparia*).
- Lesser Common Sedge (*Carex paludosa*).

GRASSES (*Gramineæ*)—

- Reed Canary Grass (*Phalaris arundinacea*).
- Water Foxtail (*Alopecurus geniculatus*).
- Fiorin (*Agrostis stolonifera*).
- Common Reed (*Phragmites communis*).
- Tufted Hair Grass (*Aira cæspitosa*).
- Yorkshire Fog (*Holcus lanatus*).
- Tall Fescue (*Festuca elatior*).
- Reed Fescue (*Festuca arundinacea*).
- Rough-stalked Meadow Grass (*Poa trivialis*).
- Water Meadow Grass (*Poa aquatica*).
- Floating Sweet Grass (*Glyceria fluitans*).

The bog indicators are:—

SEDGES (*Cyperaceæ*)—

- Deer's Hair or Draw Bent (*Eleocharis cæspitosa*).
- Draw Moss (*Eriophorum vaginatum*).
- Narrow-leaved Cotton Grass (*Eriophorum angustifolium*).
- Lesser Panicled Sedge (*Carex teretiuscula*).
- Tawny Sedge (*Carex fulva*).
- Slender-leaved Sedge (*Carex filiformis*).
- Slender-beaked Bladder Sedge (*Carex ampullacea*).
- Few-flowered Sedge (*Carex pauciflora*).
- Separate-headed Sedge (*Carex dioica*).
- Mud Sedge (*Carex limosa*).

GRASSES (*Gramineæ*)—

- Brown Bent (*Agrostis canina*).
- Quaking Grass (*Briza media*).

A very important question connected equally with marsh and bog is the richness or poverty of the soil. If a satisfactory answer to this question can easily be got, the agriculturist is in a better position for deciding whether the marsh and bog should receive more of his attention, and whether reclamation is worthy of serious consideration. If the land is productive of tall plants which grow luxuriantly and tiller freely, that is a very good indication of richness. To make the indication more satisfactory he must be sure that the productive species can only be borne by rich land, and just here the value of knowing the chemical composition of the marsh and bog plants comes in. If the productive plants compare favourably, say with Oat Straw, in the amounts of nitrogen, phosphoric acid, and potash which chemical analysis shows that they contain, then the soil may well be considered fairly rich. Using Stebler's figures, we give the analyses of a few typical plants, showing the composition of 1000 lb. of the air-dried produce:—

		Water.	Nitrogen.	Phosphoric Acid.	Potash.
	Blunt-flowered Rush (*Juncus obtusiflorus*)	140 lb.	12·4 lb.	3·2 lb.	20·8 lb.
SEDGES.	Great Sedge (*Carex vulpina*)	140 „	14·4 „	6·2 „	35·4 „
SEDGES.	Great Common Sedge (*Carex riparia*)	140 „	12·1 „	4·0 „	12·9 „
SEDGES.	Slender-beaked Bladder Sedge (*Carex ampullacea*)	140 „	9·7 „	4·3 „	10·2 „
GRASSES.	Water Meadow Grass (*Poa aquatica*)...	140 „	9·8 „	1·8 „	14·4 „
GRASSES.	Common Reed (*Phragmites communis*)	140 „	10·5 „	2·1 „	7·6 „
GRASSES.	Purple Molinia or Flying Bent (*Molinia cœrulea*) ...	140 „	6·8 „	1·6 „	5·2 „
	Oat Straw (as standard)	140 „	5·6 „	1·9 „	8·9 „

These figures show that when marsh and bog land can produce certain productive plants it must be considered fairly rich.

The plants most indicative of richness are:—

RUSHES—
- Blunt-flowered Jointed Rush (*Juncus obtusiflorus*).

SEDGES—
- Great Common Sedge (*Carex riparia*).
- Slender-beaked Bladder Sedge (*Carex ampullacea*).
- Short-beaked Bladder Sedge (*Carex vesicaria*).
- Soft Brown Sedge (*Carex intermedia*).
- Slender-spiked Sedge (*Carex acuta*).
- Lesser Common Sedge (*Carex paludosa*).

GRASSES—
- Reed Canary Grass (*Phalaris arundinacea*).
- Water Meadow Grass (*Poa aquatica*).
- Purple Molinia or Flying Bent (*Molinia cœrulea*).

The poverty indicators are:—

RUSHES (*Juncaceæ*)—
- Hard Rush (*Juncus glaucus*).
- Shining-fruited Rush (*Juncus lamprocarpus*).
- Toad Rush (*Juncus bufonius*).

SEDGES (*Cyperaceæ*)—
- Deer's Hair (*Eleocharis cæspitosa*).
- Broad-leaved Cotton Grass (*Eriophorum latifolium*).
- Separate-headed Sedge (*Carex dioica*).
- Yellow Sedge (*Carex flava*).
- Mud Sedge (*Carex limosa*).
- Carnation Grass (*Carex panicea*).
- Glaucous Heath Sedge (*Carex glauca*).

[A. N. M'A.]

Marshes, Reclamation of. — The reclamation of marsh land is similar to that of bog land. The reader should therefore consult the article BOGS, RECLAMATION OF, and also the article on DRAINAGE.

Marsh Mallow, a species of mallow common on marshes. See art. MALLOW.

Marsh Marigold, a genus of plants of the Ranunculus order with large yellow flowers like those of the buttercup, and dark-green kidney-shaped leaves, commonly found in marshes and ditches. See CALTHA.

Martins. — Like their near relative, the swallow, these birds are migrants. There are two common species: (1) the House Martin, and (2) the Sand Martin. (1) The House Martin (*Chelidon urbica*) somewhat resembles the swallow in appearance, but its tail is less deeply forked, the throat is white, and there are white feathers on the legs and feet. The birds arrive at the end of April, after the first swallows, and mostly depart in October, though some may linger till the end of the year. The mud nests resembling a half-cup, or a hemisphere with side entrance, are built under eaves and in similar places, often many together. There are five pure-white eggs, and two broods are reared in the season. The same nests are returned to year after year. House martins are purely insectivorous, and catch their prey on the wing. (2) The Sand Martin (*Cotile riparia*) is somewhat smaller than the preceding, with naked feet, legs but scantily feathered, and a reddish back. It reaches this country towards the end of March, leaving again in October. Sand martins are social like the last species, but do not specially affect the neighbourhood of dwellings. They are mostly found near streams, and nest in the banks of these, when high and of loose texture. A burrow some 2 ft. long is excavated, and the four to six white eggs are deposited at the end of this on an untidy mass of grass and feathers. Food as for last species. Both House and Sand Martin, though they must devour a proportion of useful insects, are beneficial to agriculture in the highest degree. See also article HOUSE MARTIN, with illustration.

[J. R. A. D.]

Mascall, Leonard (1546–1605), author and translator, belonged to an old Sussex family, and was born in the parish of Lindfield. The details of his life are meagre, and what is known for certain possesses little interest. He is reputed to have been a clerk in the household of the Archbishop of Canterbury. It is certain that he was acquainted with several foreign languages, and in all probability travelled on the Continent. It is erroneously stated by some of the earlier writers that he was the first to introduce carps and pippins into England. He died at Farnham Royal in Bucks. The best known of his works are: A Booke of the Arte and Manner howe to plant and graffe all sortes of Trees; Husbandlye Ordring of the Gouernment of Poultrie; and The Gouernment of Cattel. The latter is perhaps his chief work, but, like books by many other of the earlier writers, it cannot claim to be original, for much of the matter is borrowed without acknowledgment from Fitzherbert's writings. [R. H. L.]

Mash. — By mash, the groom or cowman understands wet bran or bran and linseed, but the expression is sometimes extended to boiled 'roots', as turnips, swedes, carrots, parsnips, and bran. It should be understood by all who feed bran to animals that it has quite different re-

sults when given wet and dry. Dry bran mixed with chaff or roots may be given as a nutritive food without unduly relaxing the bowels, although continuously eaten, as with many rest horses or young animals not called upon to labour, and not requiring corn. A bran mash is a mechanical laxative. It is not insalivated by grinding with a dry substance, but passes into the alimentary canal almost unaltered, as may be seen on examination of the excreta next day. Bran mashes are so frequently spoiled in the making that horses refuse them. Too dry at bottom, sloppy at top, and offered scalding hot, the sick animal is disgusted and turns away. A clean bucket should be rinsed out with boiling water, when 1 oz. of salt and 3 lb. of bran and 2½ pt. of boiling water should be stirred together, covered over, and allowed to stand for twenty minutes. [H. L.]

Mashlum.—Beans sown along with oats for a crop constitute what is known in Scotland as 'mashlum'. (For further details see art. BEANS.) The word is also applied to other mixtures of grain, and the 'mashlum bannocks' spoken of by Burns were probably derived from oats and pease. The corresponding English word *meslin* is chiefly applied to wheat and rye mixed.

Massage.—The practice of massage is of great antiquity, and has only been revived in this country during a generation or so. Natives in some parts of India employ their feet as well as hands, and the victim of colic will lie on his back while another person treads the abdomen. Manipulation with the open hand and with the knuckles to the belly of an animal similarly suffering, helps to break up gas and change the position of concretions, especially in the smaller animals; but massage as a therapeutic aid to animals is chiefly employed for muscular, joint, and tendon troubles, whether arising from sprain, rheumatism, or other causes. The employment of oils and liniments (see LINIMENTS) facilitates the working of the masseur apart from any curative properties they may possess. The arteries carry blood to a part (see INFLAMMATION), and the veins and lymphatics operate in the opposite direction. It is the latter we wish to excite to greater activity, and our massage should be towards the heart. The hair upon animals' limbs is an obstacle, but this is largely overcome by holding up a foot. General, equable, continuous pressure is what is implied, and this is found valuable according as it is practised intelligently. The existence in our midst of a whole army of well-paid masseurs is proof in itself that much skill is to be acquired and better results obtained than can be expected of the amateur, but with animals we have generally to do the next best thing, and all who have the care of them should improve their use of liniments by regard to the points above outlined. [H. L.]

Master and Servant.—

CONSTITUTION OF CONTRACT.—The contract may be entered into either verbally or by writing. For a short engagement a verbal contract is sufficient, but for contracts the duration of which exceeds one year, writing is necessary. Though the point has not been decided, the weight of opinion seems to be that, in Scotland at all events, a verbal contract bearing to be for a period longer than one year may be enforced for one year if service has been entered upon under it, but not in any event for longer than a year. If, however, a contract be constituted by writing, wanting in some of the solemnities required to constitute a binding writ, this informal writing, if proved to have been acted upon by the parties, will be sufficient to make a binding contract for the full period. No stamp is required on an agreement or memorandum for the hire of any labourer, artificer, manufacturer, or menial servant.

IMPLIED CONTRACTS.—In certain cases there may be an implied contract of service, although there is no proof of any arrangement being made either verbally or in writing. For example, where services have been rendered, as from a servant to a master, for which no sufficient reason apart from the expectation of wages can be shown, the presumption of law is that the services were not given gratuitously and that wages are due. This presumption will, in Scotland at all events, hold good even in the case of parent and child, though in such cases the presumption is more easily displaced in favour of gratuitous service than in the case of more distant relations or of strangers. In England apparently the obligation to pay wages will not be implied in the case of relatives.

COMMENCEMENT OF SERVICE.—The master is bound to receive the servant into his employment, and the servant is bound to enter upon his duties, at the stipulated time; and failure by either to implement the agreement will ground a claim of damages at the instance of the other. But the servant will be excused if the failure is due to illness or other cause beyond his control. The date for the commencement of the service may be either express or implied. In Scotland agricultural servants and half-yearly and yearly servants, apart from agreement, are understood to enter into the service at the term of Whitsunday or Martinmas succeeding the agreement. By the Removal Terms (Scotland) Amendment Act, 1890, it is provided that where the term for commencement or expiry of the service is at the term of Whitsunday or Martinmas, a yearly or half-yearly servant shall, apart from agreement, enter or quit the service at noon on the 28th of May or 28th of November respectively, and if the term day be a Sunday, then at noon on the following day.

DURATION OF SERVICE.—Where the duration of the service is not fixed by agreement there is no fixed rule for determining it—the circumstances of each case must decide the question. But local custom may infer a definite duration, and in the case of gardeners, grieves, overseers, and agricultural servants, and also in England in the case of domestic servants, the hiring is usually presumed to be for one year. In Scotland domestic servants are generally, apart from agreement, presumed to be hired for six months. Superior servants in whom trust is reposed are, apart from contract, usually held to be engaged only during mutual pleasure, and the contract

may be terminated by reasonable notice on either side.

SERVANT'S DUTIES.—The servant is not entitled to delegate his duties; therefore he must personally perform them, and the master may refuse to accept a substitute, unless the nature of the contract implies the right to delegate the work. Specific performance will not be ordered by the Court, but damages will be given for loss sustained owing to the breach.

The servant is bound, during the stipulated or usual working hours, to give his whole time to his master's service, and may not undertake any other work which would interfere with the due performance of his duties. But the mere fact that a servant undertakes other work which does not interfere with such due performance will not constitute a breach of contract. The hours of service may be express, in which case a servant cannot be compelled to work overtime, or may insist on special terms for doing so. But in the case of an emergency the master may be entitled to demand that the servant work overtime; as, for example, to do harvest operations when the season is bad and the risk of losing the crop great. The order must not, however, amount to an unjustifiable exaction of labour. In the case of domestic and agricultural servants no hours are fixed, and their attendance may be required at all reasonable hours.

Where the exact duties to be performed are not clearly defined, he must undertake all work ordinarily falling under the scope of his employment, and in special circumstances the scope may be considerably extended. But a servant cannot be compelled to undertake work clearly outwith the scope of work which is usually performed by servants in the capacity in which he is employed.

Generally speaking, the service falls to be given at the place which is either expressly mentioned, or was in the contemplation of the parties when the contract was entered into. A domestic servant must, as a rule, go with the employer temporarily to another part of the country, but cannot be compelled to change permanently from town to country or vice versa; and in any event, a servant who consents to go to a distant part of the country will, at the expiry of the engagement, be entitled to the expenses necessary for return to the place where the master was resident at the time the engagement commenced.

By old Acts both in England and in Scotland, servants cannot be compelled to do work on Sundays, unless the work be one of necessity or mercy; as, for example, the dressing of food in private families, inns, &c., or feeding horses, cattle, &c. Where holidays are fixed by statute, as in the Factory Act, the servant is entitled to take them. He is further entitled to such holidays as are recognized in the district and trade in which he is employed. In the interest of public policy, a servant may exercise his right of voting even during working hours, if otherwise he would be prevented from registering his vote. The Corrupt Practices Act, 1883, sect. 2, provides that every person, who directly or indirectly makes use of any restraint to induce or compel any person to refrain from voting, shall be guilty of undue influence and liable to punishment in terms of the Act. A servant is, in Scotland at all events, entitled to get opportunity to look out for another situation when the contract of service is nearing its termination. Thus it has been held in Scotland that an agricultural servant might absent himself from his work to attend a hiring fair, but that he must use this privilege in reason, and not make it a pretext for taking an unauthorized holiday.

WAGES.—In exchange for services rendered wages are due, and are usually in money, though frequently clothing, board and lodging, or a house is conjoined. If a contract of service be proved, and no wages are stipulated, the Court will award the *quantum meruit*, or a fair recompense for the work done. The date when the wages are due may be expressed in the contract, as where a servant is engaged for a term at a wage of so much per annum, or per quarter, or per month. In such a case the wage is due at the end of each period mentioned. In the case of agricultural and domestic servants, hired for a term or terms, the wages are due only on the completion of the term, though as a matter of custom it is usual to make payments to account.

The question of the servant's right to wages during sickness is one on which there is not much authority, and the subject is here treated apart from the statutory right to compensation for injuries received in the course of the employment. Assuming for the present that the sickness is not of sufficient duration to break the engagement, the question will depend on whether the engagement is for a term or terms, or, as in the case of artisans, &c., during pleasure. Thus it has been held that in the case of a servant whose wages are a fixed sum for service during a term or terms, they are payable in a lump sum and cannot be apportioned. In the case of artisans, &c., the wages being reckoned at so much per day or hour, are only due for work actually done, and are not due during absence from sickness. But although at one time it was thought that the cause of sickness had a bearing on the question, as, for example, where the servant was disabled by a hurt received in his master's service, such as the kick of a horse, this doctrine is no longer recognized, and if the servant be ill for an unreasonable time or become permanently incapacitated, he may be dismissed. As a rule, however, temporary illness will not justify dismissal; and while the contract subsists, the servant, even if ill, will be entitled to full wages when the engagement is a termly one. On the other hand, it has been decided in Scotland that if the sickness or injury be due to misconduct on the part of the servant, even in his master's service, no wages will be due for the period during which he is incapacitated for work.

Finally, local custom, if 'uniform and notorious' in the locality, may modify the strict rule of law; and in many parts of Scotland there is an understanding that an agricultural servant hired for a year is entitled to full wages, without deduction for absence through sickness, if he is not incapacitated for work for a longer

time than six consecutive weeks at a time, no matter how long in the aggregate he may be laid aside; but that if the sickness last for more than six consecutive weeks, a deduction is made. But the decision of the question is dependent on the circumstances of each particular case, and no absolute rule can be laid down with safety.

A master is not legally bound to provide servants with medicine or medical attendance, and this is the case even where the servant resides in the master's house or has received an injury in his employment. If, however, a master calls in a doctor, or sends his servant to his own doctor, he will be held to have undertaken liability. But now, by the Workmen's Compensation Act, 1906, practically all servants, including domestic servants, are entitled to compensation for injuries received in the course of their employment. This, however, does not apply to sickness arising from the employment, except in a few instances which are scheduled in the Act.

In England, by the Wages Attachment Abolition Act, 1870, no order for the attachment of the wages of any servant, labourer, or workman shall be made by the judge of any Court of Record or inferior Court. In Scotland wages due to a servant may be arrested for debts, but only in so far as there is a surplus beyond what is necessary for the servant's subsistence. As regards the wages of workmen, they are by Statute only arrestable to the extent of the surplus over 20*s.* per week, except in the cases of alimentary debts and rates and taxes. Moreover, the statutory enactment does not affect the common-law rule, and even the surplus over 20*s.* per week will only be arrestable in so far as not necessary for the subsistence of the debtor and his family.

In addition to money wages, board and lodging is usually implied in the case of domestic servants. In such a case the board must be in accordance with the rank of the servant, and the food must be sufficient.

If a livery be supplied to a servant, it is the property of the master, and reverts to him on termination of the employment.

In England servants do not seem entitled to any preference for their wages from executors of their deceased master. In Scotland at common law the wages of domestic and agricultural servants are preferable debts on the master's estate, but the preference does not include any sum in lieu of board. The extent of the claim is for the wages due for the term current at the master's death, *i.e.* for six months or a year or other period, according to the terms of the contract. In the case of the master's bankruptcy a similar privilege is by the common law of Scotland extended to domestic and agricultural servants. It is difficult to define exactly the limits of the privilege. Thus in the case of a farmer who also carried on business as a wright, it was held the privilege extended to his farm servants, but not to the workmen employed in the trade.

By Statute the wages of clerks, shopmen, and servants employed by the bankrupt are entitled to a preference to an extent not exceeding four months' wages prior to the date of the bankruptcy, and not exceeding the sum of £50; and labourers or workmen employed by the bankrupt are entitled to a preference to an extent not exceeding two months' wages prior to the same date, and (in England, or where, in Scotland, the employer was a limited company) not exceeding £25.

Termination of the Contract.—The contract may be brought to an end by the expiry of the time fixed by the agreement; and where a definite time is fixed no notice is required, except in Scotland in the case of agricultural and domestic servants. If no definite time is fixed, and in Scotland in the case of agricultural or domestic servants whether a time be fixed or not, notice on one or other side is required to terminate the relationship.

Notice.—The notice need not be formal. It may be given verbally, or even by implication, so long as the actings of the party show clearly that the relationship is to cease. 'Whether, in any given circumstances, the giving of notice is to be inferred from the actings of the parties, is always a jury question.' Thus, where a master resolved to let his garden, and advertised it, and his gardener, in the knowledge of this, applied for but did not obtain another situation, it was held that notice was not to be inferred.

The length of notice, if not fixed by the contract, must be reasonable, and in the case of agricultural and domestic servants, and generally servants usually hired by the year or half-year, this has been held in Scotland to be forty days. If, in Scotland, the servant is hired for a term expiring at Whitsunday or Martinmas, the forty days' notice must be reckoned from 15th May or 11th November as the case may be, and not from the 28th day of these months, when the service actually terminates; in other words, the notice is really fifty-three days prior to actual date of ceasing service in May, and fifty-seven days prior to actual date of ceasing service in November.

Tacit Relocation.—In Scotland where notice is required, either by agreement or custom, and none has been given, the contract will be renewed by tacit relocation, *i.e.* a presumed intention that all the stipulations and conditions of the original contract shall remain in force in so far as 'not inconsistent with any implied term of the renewed contract'.

Thus, in the case of all servants who are entitled to notice, if nothing has been said or done on either side to show the definite determination to terminate the contract, or if the notice given expressly or impliedly is insufficient, tacit relocation will be presumed. The servants entitled to notice, and to whom the doctrine of tacit relocation applies, are agricultural and domestic servants and the like hired by the year or half-year. Thus a gardener, a farm manager, a shepherd, a hedger and ditcher, and a gamekeeper have all been held to be within the class of servants to whom the doctrine applies.

Where, however, no notice is necessary, tacit relocation will not apply. Thus it has been held not to apply to the case of workmen in whose case custom does not require notice to be given.

Death.—The death of either master or servant

dissolves the contract. In the case of the death of the master, the servant must continue in the service of the family till the term succeeding the master's death, or the term thereafter, if notice has not, or cannot, timeously be given before the succeeding term. If discharged before this term, the servant may claim wages and board wages, subject of course to deduction for wages earned in other employment, which he is bound to seek. As already mentioned, however, his claim is only a preferable one to the extent of wages and not for board wages. On the death of the servant, his executors are entitled to the proportion of wages due for the period he has actually served.

Sickness.—As a rule the illness of the master or servant does not terminate the contract. But the illness may be so serious, or of such a nature as to preclude one of the parties from fulfilling his part of the contract, in which event the other party will be free. Thus, if a servant become permanently incapacitated for service, or if he be laid aside by illness for a long period, he is manifestly prevented from carrying out his bargain, and the contract will end. As already mentioned, custom has in many parts of Scotland fixed six weeks as the duration beyond which illness of a servant may not extend without giving the master the right to terminate the bargain. Moreover, where the injury or illness is due to the misconduct of the servant, this in Scotland, though apparently not in England, will constitute a breach of the contract, independent of the duration of the illness. Where the contract is brought to an end by an illness of the servant for which he is not responsible, he will be entitled to wages for the period during which he has actually served.

Bankruptcy.—The bankruptcy of the master does not terminate the contract in England, though it would in Scotland. The rights of the servant in that event have already been referred to.

Dismissal of Servant.—The contract may be brought to an end by the master dismissing the servant. This he may do at any time without reason, on payment of damages, which are usually computed to be the wages to the end of the contract, with the addition in some cases of board wages. On the other hand, the servant may, at any time, leave on payment of damages for breach of contract.

But circumstances may arise which will justify a master in dismissing a servant without payment of wages to the end of the term, or board wages. These circumstances will generally fall under one or other of three heads: (1) Disobedience or want of respect; (2) dishonesty or misconduct; and (3) neglect or incompetence.

1. *Disobedience or Want of Respect.*—Wilful refusal to perform a lawful order of the master, or the deliberate contravention of an order, will justify immediate dismissal. But the order must be one which is lawful; it must be one which properly falls within the scope of the servant's duties, and such as will not expose the servant to personal injuries not necessarily involved in the employment for which he was engaged. Moreover, the disobedience, if merely occasional or in trifling matters, will not as a rule justify immediate dismissal; but if, after reprimand, the offence is repeated, the matter will be different.

The servant must treat his master with due respect, and gross insolence will always justify dismissal. The capacity in which the servant is employed will enter into a consideration of the offence, for what might be gross insolence on the part of a menial servant, might be more excusable on the part of one holding an important or confidential position. While, therefore, in the case of the latter, a single instance of insolence might not justify dismissal, the same rudeness on the part of a menial servant might be held to do so. The question is largely dependent on the circumstances of the case, and the test will usually be whether the conduct complained of was so insolent and insubordinate as to be incompatible with the continuance of the relationship of master and servant.

2. *Dishonesty or Misconduct.*—An act of dishonesty, such as theft or wilful destruction of the master's property, will justify dismissal. A servant who cheated his master's customers, or who made false entries in the books and false statements to his employers as to the conduct of the business, or who took secret commissions from his employer's customers, has been held liable to dismissal.

Drunkenness, *i.e.* habitual or frequent intoxication, if during working hours, or if it interferes with the performance of the servant's duties, is always a good ground for dismissal. Probably an isolated case of an outdoor servant, especially if at some festive or holiday season, will not justify instant dismissal; but even a single case of intoxication on the part of a servant in a different position, *e.g.* a tutor, a governess, or a nurse, would be sufficient ground for dismissal.

Immorality on the part of domestic servants, or those employed in the house, as tutors or governesses, will always justify dismissal. Whether immorality on the part of outdoor servants will have the like effect, will to a certain extent depend on whether the conduct interferes directly or indirectly with the discharge of the servant's duties. Thus, in one case the foreman on a farm was held to be justifiably dismissed for immoral conduct with the female workers on the farm, which led to quarrels between his wife and the workers, and consequent interruptions of the farm work.

The act of dishonesty or misconduct complained of must have occurred during the term of service, for if, after the contract has been entered into, the master finds that the servant, prior to entering his employment, has been guilty of such an act, this will not justify dismissal. The master must either allow the servant to implement the contract, or if he prefer, dismiss him on payment of wages, and board wages where due, to the end of the term.

3. *Neglect or Incompetence.*—Persistent neglect of duty, or absence from work during the recognized hours of labour without leave, will justify dismissal. What amount of neglect or absence will be sufficient, will always depend on circumstances; the nature of the services to be rendered, and the consequence of the neglect

or absence, being important factors in coming to a decision.

In entering into a contract of service, the servant must be held to have undertaken that he is reasonably fit for the employment contracted for. If, therefore, he is incompetent, he may be dismissed, for it has been said: 'There is no material difference between a servant who will not, and a servant who cannot, perform the duties for which he was hired'. The point will be more easily determined where the servant is employed for a definite duty than where he is engaged for general work. But if the master, when engaging the servant, was told, or can be shown to have been aware, that the servant had not formerly done the work he undertook, he would probably not be entitled to dismiss him, since he will be held to have taken the risk.

The servant must exercise due care so as not to waste or destroy his master's property, but he is not responsible for loss caused by an accident beyond his control. The extent of care due will vary with the nature of the employment and the probable results of the carelessness. The breaking of a teacup could not reasonably be held to argue any serious want of care, but a single act of neglect or forgetfulness in another station might involve such serious consequences as to justify instant dismissal.

Consequences of Breach of Contract.—The failure of a party to a contract to implement his obligations under it, subjects him to a claim of damages at the instance of the other party. The claim may be at the instance of either master or servant.

1. *Master's Claim.*—Where a servant without good reason refuses to implement his bargain, or where he is justifiably dismissed, the master has a claim for damage proved to have been caused through the loss of the servant, and these damages will be ascertained in the usual way by proof of loss sustained. In the same way the master has a claim for loss sustained through the negligence or misconduct of his servant. Moreover, the servant, on leaving or being justifiably dismissed, is only entitled to the wages actually due at the date when the contract terminated. Where, therefore, the wages are due at the end of a term, *e.g.* one month or six months or otherwise, a servant leaving without reason, or justifiably dismissed, cannot sue for a proportion of the wages applicable to the period of the term served, since each term is treated as a whole, and the wages for the broken period are not apportionable.

2. *The Servant's Claim.* — The servant's claim for damages usually arises on wrongous dismissal, and the damages are usually computed to be the wages due to the end of the contract, together with board wages, when board and lodging formed a part of the servant's remuneration. But a servant is not entitled to sit down and neglect, or refuse, to seek other employment, and if he gets other employment his claim of damages will be subject to reduction by the amount of his earnings elsewhere. The claim will, as a rule, be limited by the amount of wages, and where due board wages, but is not necessarily so in the case of a servant employed for a definite term.

Character.—On the termination of the contract, the master is under no legal obligation to give the servant a character; but if he do so, he must give it in good faith. In giving a character in good faith to anyone who has an interest to receive it, the master is privileged, and is not liable to an action for damages at the instance of the servant, for statements damaging to the servant's character, unless malice on his part be proved.

If a master gives a servant a character it must be true to the best of his knowledge and information; for if he make representations which he knows to be untrue, and another employer in reliance on these statements gives the servant employment, the second employer would, in England, be entitled to recover damages for loss sustained in consequence of the employment of the servant. It is doubtful whether this statement of law is applicable to Scotland.

By the Servants' Character Act, 1792—which it is thought applies to Scotland—it is provided that anyone who falsely personates, or in writing gives any false character to, any person offering himself to be hired as a servant, shall upon conviction be liable to a penalty of £20, or, on default of payment, to imprisonment with hard labour. Any person who deliberately makes false statements with regard to the period of service or date of discharge of any servant, and any servant who makes any false assertion with regard to his service or presents a false or forged certificate, or in any way alters any character which has been given to him, is liable to the same penalty.

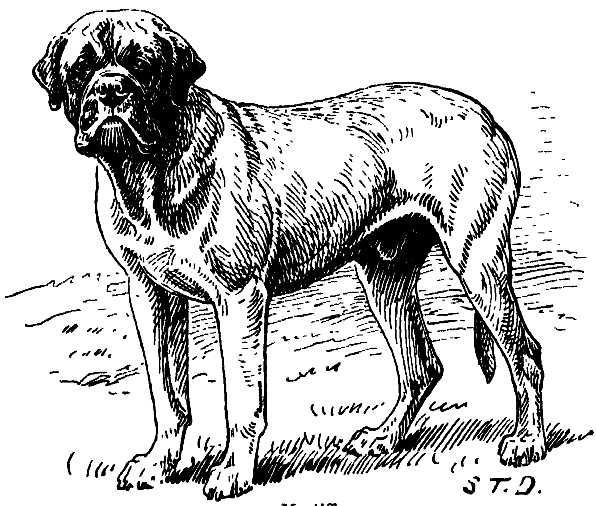
Master's Liability to Third Parties for Servant's Acts.—The question of the master's liability to third parties for the acts or contracts of the servant will depend upon whether the servant has authority to enter into the contract or do the act. While it is the case that the master is ordinarily responsible for the act of the servant, he may escape responsibility for such act if he has not ordered or authorized the thing to be done, and more especially if he has forbidden it. Where, however, something is done which is in the common line of the servant's duty, no special instructions having been given, the master is liable for the servant's acts, and, so long as the servant is acting within the general scope of his employment, a prohibition as to the manner or place of doing an act within that employment does not relieve the master from liability for the servant's negligence. On the other hand, a master is not responsible for the illegal act of his servant, and therefore is not, as a general rule, liable to be punished for any crime or fraud committed by him, though in the course of his business, unless the master knowingly benefits thereby. He may, however, even incur a penal responsibility for the illegal act of a servant under the provisions of certain statutes, *e.g.* Foods and Drugs Acts, &c. Moreover, the master may be involved in civil liability for the criminal act of a servant, as, for example, where the servant, exceeding his duty, has committed an assault.

The liability of a master to compensate his servant for injuries sustained in the course of

his employment is now largely regulated by statute, and is not dealt with in this article. See under WORKMEN'S COMPENSATION ACT. [D. B.]

Mastication.—The importance of mastication can only be properly appreciated by those who understand that digestion begins in the mouth. Food is seized in different ways—by the lips, tongue, and teeth, by horses, cattle, and dogs; but saturation with saliva (insalivation) can only be properly effected by thorough mastication. The various glands which contribute the salivary fluid provide ptyalin and salts, the first-named being a special ferment destined to act after deglutition. Unless food is properly dealt with in the mouth, perfect digestion does not follow in the herbivora. Carnivorous animals secrete more hydrochloric acid in the stomach, and to them the foregoing rule does not apply with equal force. Dry chaff is given to animals to compel them to grind their corn ere they can swallow it; and it is best for them to do it themselves, unless defective teeth render it impossible. The mouth should be examined, with special regard to the teeth, when it is found that mastication is imperfectly performed. See also DIGESTION. [H. L.]

Mastiff. — To the regret of many people the old English Mastiff, the breed which in the opinion of some is entitled to dispute with the Bulldog the title of the national dog of England, has fallen upon evil times. No doubt the ancient variety has suffered a good deal from the popularity of the St. Bernard and Great Dane, but there remains the fact that the day of the Mastiff, or in fact of most of the large breeds of dogs as guardians of houses, has passed for ever. In former times the services of such animals were largely in request for the above purpose, and there can be no doubt that they were also utilized for capturing deer and other big game —so much so indeed that a law was passed which enacted that under certain conditions a foot should be cut off, so that the dog should be disabled so far as poaching operations were concerned.



Mastiff

Beyond all doubt the Mastiff and Bulldog possess a common origin, as observed in the description of the latter breed, but during the past century the two varieties have lost many points of resemblance which they formerly possessed. That the Mastiff is a most courageous variety there can be no possibility of a doubt, as the perfectly trustworthy stories which have reached us of his attacks upon lions and bears when these animals were used for baiting purposes provide conclusive evidence on the point. The Mastiff, however, is disposed to be a little uncertain in his temper, which is a serious matter in the case of a dog of his size; but there can be no doubt that if properly trained whilst young, he is much more amenable to control in later life than is generally supposed.

A great point of the Mastiff is his head, as his skull should be massive, broad and square, whilst the muzzle should be rather short, blunt, extremely powerful, and well filled up under the eyes, a falling away at this part being a great fault, and there is a wrinkling of skin on the head above the forehead. The eyes are rather sunken, of a dark hazel colour—a yellow shade being most objectionable—whilst the ears are small, pointed, and carried flat to the sides of the head. The neck is very powerful indeed, the shoulders fairly sloping, and the chest both wide and deep, the fore legs being dead straight and very heavy in bone. The body is long and muscular, well ribbed up at the loins, and the tail, which is coarse and rather long, is carried in a downwards position. The coat is short and harsh, and the average weight about 170 lb., the recognized colours being brindle, or fawn with black ears and muzzle, white markings being regarded as most objectionable. [V. S.]

Materials of Construction — Strength, Elasticity, and Testing of.—When a bar of uniform section is acted upon by a simple stress which is uniformly distributed over the section of the bar and which gradually increases in intensity until fracture takes place, the stress per unit of the original sectional area of the bar just before fracture occurs is called the *breaking* or *ultimate strength* of the material of which the bar is composed. Now there are three different kinds of simple stress, viz. simple push, simple pull, and simple shearing stress. Thus, if a short strut, A B, of sectional area Δ, be acted upon by a load W, as represented in fig. 1, then across any transverse section, C D, there will be a simple push stress of intensity $= \frac{W}{\Delta}$. Similarly, in the tie, fig. 2, which is acted upon by a pull, P, in the direction of its length, the simple pull stress across the transverse section C D will have an intensity $= \frac{P}{\Delta}$; and in the pin

joint, fig. 3, the pulls P in the rods A′ and B′ will tend to cause the central portion of the pin to slide over the end portions at the sections A B and C D, as shown in fig. 4, thus producing simple shearing stresses at these sections of intensity $= \frac{1}{2}\frac{P}{\Delta}$, where Δ is the sectional area of the pin, and $2\,\Delta$ the combined area of the two sections over which the shear is distributed. Again, at any transverse section, C D, of the strut shown in fig. 1, there is, as we have already observed, a simple push stress W acting, which produces a unital stress, or stress per unit of area, of $f_c = \frac{W}{\Delta}$. If we now take an inclined section, mn, fig. 5, the total stress over mn will still be W. Resolving W normally and tangentially to mn, as shown in fig. 6, we get, for the normal component: W sin θ, and for the tangential component: W cos θ. The tangential component tends to cause the upper part of the strut to slide over the lower part as shown in fig. 7, and since the area of the section $mn = \Delta$ cosec θ, the unital stress over $mn = \frac{W \cos\theta}{\Delta \operatorname{cosec}\theta} = f_c . \sin\theta . \cos\theta = \frac{1}{2} f_c \sin 2\theta = f_n$, say, which is a maximum, and $= \frac{1}{2} f_c$ when $\theta = 45°$. The resistance actually offered to the sliding along nm of the upper part of the strut over the lower part will, however, exceed the shearing resistance of the material by that due to friction, and if ϕ be the angle of friction the section mn along which such sliding tends to take place will make an angle $= 45° - \frac{\phi°}{2}$ with the vertical. From the above investigation we see why short struts of such materials as timber, cast iron, brick, and many kinds of stone of which the shearing strengths are less than half the crushing strengths, fail when tested to destruction by shearing and not by crushing. Short struts of cast iron, for instance (for which material the crushing strength is some six or seven times the shearing strength), fail by shearing along planes making an angle $= 45 - \frac{\phi}{2}$, or about 34° with the vertical.

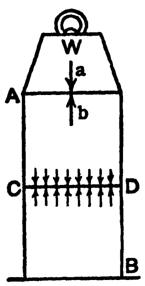


Fig. 1

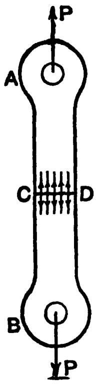


Fig. 2

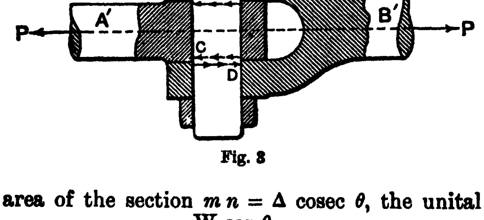


Fig. 3

STRAIN.—When a body is acted upon by a stress it undergoes a deformation, called strain, which consists either of a change of form or dimensions, or of both. If the strain thus produced by a stress diminishes as the stress is reduced, and finally vanishes with the stress, the body is said to be an 'elastic' body, and for such bodies the strain is proportional to the stress applied. If the strain, however, does not diminish as the stress is reduced, but remains permanent after the stress is entirely removed, the body is called a 'plastic' body, and the strain the 'permanent set'.

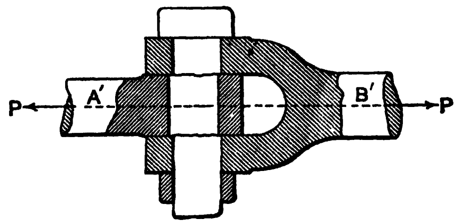


Fig. 4

All solid bodies are nearly or entirely elastic for stresses up to a certain limiting value, beyond which they are partly elastic and partly plastic. If a uniform bar of mild steel, for example, be acted upon by a gradually increasing pull stress, the successive effects of the stress upon the bar will be as shown in fig. 8, and as represented by the stress-strain diagram fig. 9, in which diagram the ordinates to the curve, O y x M N, represent stress applied per unit of original sectional area of the bar, and the abscissæ the percentage elongations produced thereby. As represented by the straight line O E, the strain is proportional to the stress so long as the unital stress does not exceed a certain limit—about 17 tons per square inch—called the 'elastic limit', or the elastic strength of the material, and up to this point the strain is entirely elastic. Beyond this point, E, however, the strain increases more and more rapidly with the stress

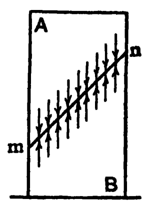


Fig. 5

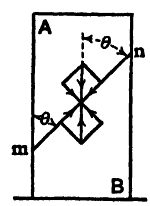


Fig. 6

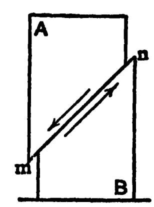


Fig. 7

until the point *y*, called the *yield point*, is reached, when, without any further increase of stress, the bar elongates quite perceptibly, as represented by *y x*. The bar then recovers itself, so that a further increase of stress must be applied in order to produce an increase of strain, but

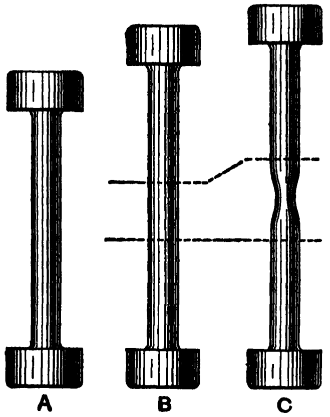


Fig 8

A, shows the original bar; B, the bar at maximum load; and C, the form the bar assumes just before fracture occurs.

the strain increases with the stress at a continually increasing rate until the point, M, of maximum resistance is reached, after which, even with a rapidly diminishing load, local extension takes place and the bar fractures.

Up to the point M the extension is general, and its total amount is proportional to the length

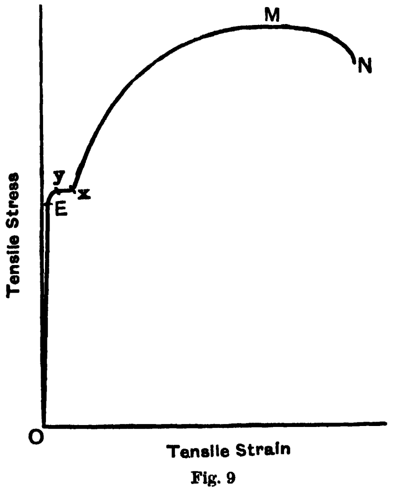


Fig. 9

of the specimen; but after the maximum load has been reached any further extension which takes place is 'local', is due to a local drawing-out of the bar in the immediate neighbourhood of the point of fracture, and its amount is proportional to the diameter of the bar, in the case of round specimens.

The total elongation thus produced in a bar will depend not only upon its length, but upon its diameter also. A mild steel bar 10 in. in length and 1 in. in diameter, for example, will extend about 2·5 in. before fracture occurs, or about 25 per cent of its original length: while a bar of the same material, 8 in. in length and 1 in. in diameter, would probably have a total elongation of 30 per cent. That is to say, the shorter the bar is, compared with its diameter, the greater will be its percentage elongation.

Autographic stress-strain diagrams for such brittle materials as cast iron and hard steel differ considerably from that shown in fig. 9, for as there is no perceptible local elongation there is no droop, such as M N, in the curve; and neither the elastic limit, E, nor the yield point, *y*, are very definitely marked.

Modulus of Elasticity.—Up to the elastic limit the ratio of the unital stress applied to the extension produced per unit of original length of the bar is constant, and its value is called 'the modulus of direct or longitudinal elasticity', or Young's modulus. Thus, if a pull of P tons acting upon a bar of Δ square inches in sectional area and length L inches extends the bar by amount l inch, then $\frac{P}{\Delta} \div \frac{l}{L} = E$ tons per square inch, where E is Young's modulus. For mild steel E is equal to about 13,500 tons per square inch, so that for a bar 10 in. in length having an elastic strength of 17 tons per square inch, the elastic extension would be:

$$l = \frac{P \cdot L}{\Delta\ E} = 17 \times \frac{10}{13{,}500} = 0{\cdot}0126 \text{ in.}$$

For most materials Young's modulus is nearly the same for both compression and tension, and its value, in tons per square inch, varies from 13,000 to 14,000 for steel, from 12,000 to 13,000 for wrought iron, and from 6000 to 9000 for cast iron.

Ultimate Strength.—To each of the three different kinds of simple stress, viz. simple pull, push, and shearing stress, there is a corresponding ultimate strength for each material. Hence each material has, usually, three distinct ultimate strengths, viz., (1) tensile strength, (2) crushing strength, (3) shearing strength; and these may be defined as the maximum resistances which a bar of unit sectional area can offer to a simple pull, a simple push, and a simple shearing stress respectively.

The table on p. 214 shows the ultimate strengths of different materials, the values given being either the average or the minimum and the maximum.

For ductile materials, such as mild steel, wrought iron, lead, soft copper, &c., there is no such thing as 'ultimate crushing strength'. There is, however, for each an apparent elastic strength or limit, but when the unital push stress exceeds this limit the material simply spreads and increases the area of the cross sectional area indefinitely under an increasing load. For mild steel and wrought iron, the elastic strengths in compression are about equal to those in tension, and each is a little greater than half the ultimate tensile strength.

ULTIMATE STRENGTH OF DIFFERENT MATERIALS IN TONS PER SQUARE INCH

Material.	Tensile Strength.	Crushing Strength.	Shearing Strength.
Cast iron	7 to 10	40 to 50	9 to 11
Wrought-iron bars ...	20 „ 24	22	15 „ 18
„ plates ...	19 „ 21	—	14 „ 16
Steel, mild	28 „ 32	—	21 „ 24
„ rivets	26 „ 29	—	—
„ rails	30 „ 40	—	—
„ castings	25 „ 35	—	—
„ wire	70 „ 90	—	—
Copper, cast	9	—	—
„ hard-drawn ...	20	—	—
„ annealed... ...	13	—	—
Brass, yellow	8	4·5	8 to 10
Timber, along the grain—			
Oak (British)	4 to 8	2 to 4	—
Ash	2 „ 7	4	—
Yellow pine	1 „ 2	2 to 2½	—
Red pine	2 „ 6	4 „ 5	—

SAFE WORKING STRESS.—In order that a structure may not be permanently deformed, no member of the structure should be stressed beyond its elastic limit. Further, in order to provide for possible hidden flaws, for wear and tear, for accidental loads, and for other contingencies, such as the peculiar effects of often-repeated and varying stresses, a further margin of safety is required. For these reasons the working stress should never exceed about a third, or a fourth, of the breaking stress, and in some cases, especially where the stress applied has a wide range of variation and is often repeated, the safe unital working stress may not be greater than a tenth, or even a twelfth, part of the ultimate strength.

The ratio of the ultimate strength of, to the unital working stress allowed in a member is called the 'factor of safety', and its value varies in different cases from 3 to about 12. [H. B.]

Mat Grass.—This name is applied to two distinct genera of grasses: (1) *Marram Grass*, or *Sea Mat Grass*, a perennial grass found on dry sandy seashores (see PSAMMA); and (2) *Moor Mat Grass*, a stiff perennial common on dry heaths and moors. See NARDUS.

Mating Animals.—Mating domesticated animals in order to produce the most desirable progeny is the crucial test of the breeder's art, for it involves a knowledge of the principles of breeding and selection, and the practical application of his powers of observation. A proper mating assumes the bringing together of male and female of worthy lineage and the highest type in form and function, and theoretically no difficulty ensues, nor are any rules required; but in fact all animals are imperfect, and mating aims at the elimination of defects, so that what is lacking in the parent may be found in the offspring. Thus it would be folly to mate a flock of ewes of thin and open wool with a male of similar fleece. On the contrary, the ram should be remarkably good in fleece in order to correct this defect. When the females are good of their kind but of different types, a greater difficulty arises, and in time is overcome by using males of the type desired, and retaining only those females which approach it. When several males can be used the result is obtained more quickly, for each group of one type will be mated with the male most likely to bring it nearer to the standard. Thus a Shorthorn breeder may use several males for a herd of thirty cows, and not only mate those most suitable in shape, but those of such pedigree as experience tells him will 'nick' or blend the best.

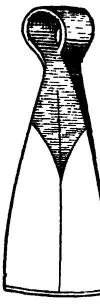
When a whole herd or flock is defective in one point, as, for instance, in touch or mellowness of flesh, the male should not merely be superior in that characteristic, but of prepotent stock, in order to impress the character upon his progeny. Violent matings are seldom successful, *i.e.* the mating of different species, as the cow with the bison, though the valuable mule is bred by mating the ass and the mare. The mating of two very distinct types of the same breed to produce a blend is not usually successful. It will generally be found better to grade up one type to the desired form rather than to attempt its sudden production. The mating of two different breeds to produce a cross such as the 'blue-grey' cattle, requires exceptional skill in selecting the parents, and similar skill is necessary in selecting to produce one or other of the numerous types of cross lambs. In general, what breeders call 'hard' crosses should be avoided, *e.g.* Galloway and West Highland cattle, or Cheviot and Shropshire sheep, the idea being that slow-maturing breeds mate better for beef or mutton purposes with quick-maturing strains; and similarly that 'soft' crosses, in sheep at least, such as Leicester and Border Leicester, or Leicester and Lincoln, are undesirable.

At the time of mating, animals should be undisturbed, and females are more likely to conceive when under natural conditions, when not too fat or too lean, and when grazing, or living chiefly on succulent food. The mating should be attempted only when the female is 'in season' or at the period of natural heat; and in the case of the second and subsequent impregnations of sheep and pigs, only after the offspring are weaned. The mating of immature females stunts their growth, and, except in the case of dairy

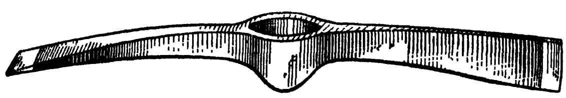
heifers, is to be avoided. Young rams, boars, and bulls may, however, serve a limited number of females without injury. Consult also articles on BREED; BREEDING, LAWS OF; &c. [R. B. G.]

Matricaria, a genus of Compositæ most of the species of which are yellow-flowered annual herbs widely distributed over the Old World. The double-flowered form of *M. inodora*, a native weed, is the only one cultivated in gardens. Of creeping habit, it has large white flowers, and is a good border plant for autumn effect. Propagation by division or cuttings in autumn or spring. [W. W.]

Mattocks are heavy chopping tools, generally somewhat adze-shaped, and are used after the manner of a pick, in fact a pick with a chisel end or with a wide cutting edge possesses the features of a mattock. Mattocks are made as single- or double-headed tools; usually the broader-headed ones are single and the narrower ones are double, but this is largely controlled by local custom and the use to which they are put, so there is no definite rule. Moreover, the term itself is not consistently applied, for it is used to denote any kind of chopping hoe, as well as broad-faced picks used in cutting wood. The double-headed mattock, having one end with a cutting edge in line with the handle and the other at right angles to it, is well suited to stub up hedgerows or to take out tree roots. Road mattocks are generally made with one pick end and one chopping end, but for roadside edging a form of mattock hoe with one very broad and one narrow blade is more suitable. In some districts, especially on heavy land, a similar type of mattock, or one with a single blade, is commonly used for hoeing farm crops. Such hoes are not suitable for making a long stroke, and the land is chopped rather than hoed. [W. J. M.]



Mattock



Double Cross-cut Mattock

Mawbound. See IMPACTION.

May, Calendar of Farm Operations for.—

1. SOUTHERN BRITAIN

ARABLE LAND.—In the early part of this month the principal work is getting the last break of mangels sown. The earliest break of mangels and kohl-rabi should be forward enough for singling by hand and for horse hoeing. Beans, peas, and all cereal crops are horse or hand hoed from now onwards. Topdressings of artificial manures may be applied to cereal crops, and some nitrate of soda is often sown on the drills of the first break of roots if the young plants are forward enough.

At odd times during the month the fallow is generally cross ploughed. The late crop of potatoes is now planted, and the earliest varieties are being hoed. Land is got ready for sowing swede turnips at the end of the month. Buckwheat, lucerne, and sainfoin are drilled now, and grass seeds can still be sown. Maize seed may be put in with a good dressing of dung, for use as a green fodder in August and September when cow pastures become very much burnt up. The earliest cut of young lucerne is often taken at the end of May.

STOCK.—This is the month when the majority of mares are put to the horse. There may be a few late foals. On farms where the horses are not always kept in yards, they should be out in their paddock at night by now. Dairy cows should be on summer rations and be out in the fields all night, and as food should be plentiful there will be a large milk yield. They should, however, be given a little undecorticated cotton cake, as the grass may be too succulent and have a tendency to cause scour. The cowmen should not neglect to clean and currycomb the cows now that they are out in the fields, when they have been in the habit of doing so while the cows were tied up. A lump of rock salt should be accessible in the fields. Fat cattle are sold off as they attain their prime. Those that are being fattened are generally out in the fields, but are brought up to finish. Young as well as store cattle are all out at grass, but are housed on very wet nights and receive a ration of oilcake.

There is an abundance of food for sheep and lambs now. These should be watched carefully, or they may become struck by the fly and maggoty on hot days. If there is a continuance of warm weather, the sheep should be dipped to clean the fleece, as it is getting close to shearing time now. The pig sty should be full on dairy farms, and young pigs getting the whey and barley meal, &c. There is plenty of green fodder for them now. The sows should be allowed out for exercise, but the farmer ought to see that the hedges are in good order or they may wander. In the poultry yard eggs are cheap and plentiful. Hens are still broody and bringing off clutches of chickens or ducks. These should be allowed to run about the fields, but not if it is wet weather or if they are very young. Young ducks intended for fattening should be kept away from the water. As there is no stock in the yards there is very little food for the poultry to pick up, and they must be fed accordingly. [P. M'C.]

2. NORTHERN BRITAIN

ARABLE LAND.—If there is any part of the potato crop still to plant, it should be attended to without delay. In districts where early varieties of turnips are grown for table use, these may be sown from the beginning of the month forward. Ryegrass and clover seeds where not already sown on spring-sown grain or on wheat should be attended to at the first favourable opportunity. On wheat the land

should always be well harrowed before the seed is sown, and again with a light harrow after sowing, and the roller should follow on as soon as possible. Potatoes planted in March or April will require to be harrowed down, and if annual or root weeds are likely to be troublesome the drills may require to be remade and again harrowed down before the plants appear above-ground. Where carrots are grown they will be ready to weed during the latter end of the month. This should be done as soon as the rows of young carrots are distinguishable, as when left too long the weeds soon smother the crop. Mangels may still be sown in the first half of the month, as in doing so it saves much time and facilitates weeding if the seed is germinated before sowing. This is best done by keeping it damp, not wet, in shallow pans 3 in. or so deep, in any warm place, and drying in the sun and sowing the seed as soon as the first sprouts appear. The main work of the month will be the preparation of the land for the turnip crop. Any cultivation and cleaning necessary should be done before the crop is sown, as it is bad practice to first sow the crop and attempt to clean the land afterwards. A good deal can be done in this respect; but where land is really dirty, the bulk of the weeds should be gathered and carried off before the crop is sown. Swedes may be sown from the middle of the month forward, and yellows during the last week. Wherever much cultivating or weed collecting has been done, the land should always be ploughed before drilling begins, for notwithstanding all that has been said against the plough as a cultivating implement, no other one leaves the land in such good condition for receiving the seed. Where the land is dry, and more especially during dry weather, all land drilled should be seeded that afternoon. If the weather is very dry, the drills should be at once rolled. Any inattention to these details will be sure to result in a poor braird, and probably the partial or whole loss of a crop.

Stock.—Stock of all kinds will be put out to the grass some time during the month, but at first should always receive more or less artificial food, as it is rarely desirable to transfer them from winter fare to fresh young pasture all at once. As a full bite of grass becomes available, the hand feeding may or may not be discontinued, for it is very difficult to get cattle to eat any extra food if they have plenty of young succulent grass. During the end of the month, calves may be put out to grass during the day, but on no account should they be left out at night during this month. [J. S.]

May, Calendar of Garden Operations for.—

1. Southern Britain

In well-regulated gardens all important operations will have been completed before May, and the duties of the gardener are then principally those of tending and cultivating. Should there be a scarcity of rain, water must be supplied by means of the hosepipes and watering cans. When this has to be done it is better to afford a good soaking at moderate intervals than to merely sprinkle the soil frequently. The plants should be encouraged to root deep into the soil, and when this is kept moist only on the surface their roots do not penetrate deep enough to be safe. Weeds should be kept under by hoeing wherever the hoe can be applied, the cutting out of the weeds serving also to loosen the surface soil, which favours aeration and is conducive to good growth. The transplanting of seedlings of the cabbage tribe, and of lettuces, should be proceeded with when the weather conditions are favourable. Seeds of the tenderer vegetables should be sown early in the month, viz. kidney beans, beet, broccoli for main crop, cardoons, cauliflowers for autumn, endive, scarlet runners. Succession sowings should be made of borage, carrots, lettuce, parsley, peas, radishes, spinach, and turnips. Celery trenches should be got ready for the plants to be set out early in June. Tomatoes may be planted towards the end of the month in sheltered borders or against walls. Hotbeds for cucumbers should be prepared, and used after the first flush of heat for growing on such plants as would be benefited by the conditions it affords.

Spraying to keep down insects and fungoid diseases is most efficacious when practised in May and the first half of June. All careful growers of hardy fruits now resort to the excellent contrivances for applying the various mixtures known to preserve fruit crops from the attacks of pests, which, if not kept under, are most destructive. Directions for the use of spraying mixtures are given under that heading. The removal of superfluous shoots from trained fruit trees, or the shortening of such as start with too much vigour, should be done as soon as they are long enough to be treated. It may be necessary to thin the fruit on trees that have set more than they are able to carry, although generally, and especially on sturdy orchard trees, the process of thinning is performed by the trees themselves, the superfluous fruits falling off through lack of nourishment before they grow to any size. Strawberry beds require close attention during May, mulching between the rows and watering the plants liberally in dry weather being helpful to the production of a full crop of good-quality fruit.

Greenhouses and conservatories may be relieved at the end of the month by the removal of the hardier plants to a sheltered position out-of-doors, where, if they are not allowed to get dry at the roots, they are much happier than when kept under glass all summer. Chrysanthemums should be placed in the pots in which they are to remain until they flower. The work of summer bedding may be proceeded with after the third week in May. There will be plenty of work on the lawns now, and if there are weeds to be removed from the grass there is no better time than May to do it. Bulbs that have been lifted to make room for bedding plants should be kept in a shaded place out-of-doors until their leaves have withered, when the bulbs should be cleaned and stored in a dry cool shed. [W. W.]

2. Northern Britain

The various crops planted earlier in the season will require close attention as to thinning, staking, earthing up, &c. The thinning out of seedlings ought to be done as soon as the plants can be conveniently handled. The hoe must be constantly used to keep down weeds.

Sow successional lots of peas, lettuces, radishes, and other salading, turnips, carrots, and beetroot. A sowing of kidney beans may be put in about the 21st, which is early enough in most places where there are possibilities of late frosts. Another sowing can be made ten days later, when the first lot of runner beans may likewise be put in.

Plant out successional lots of cabbage and cauliflower, also onions and leeks, which have been raised indoors, as weather conditions permit and other circumstances warrant. Prick celery out in frames, and prepare the trenches to be in readiness for the crop. Pot on vegetable marrows and cucumbers for frame culture.

In the floral department seeds of many annuals can now be sown outdoors with safety.

When it has been impossible to get violas and carnations planted earlier, no time must now be lost in having them put in their places. By the middle of the month preparations must be made for the planting out of the hardier kinds of bedding plants. Unless in favoured localities, there is a risk in beginning before the last week of the month.

The 'hardening-off' of plants in frames must be done judiciously. Also be more careful in the watering for a time, keeping such plants as pelargoniums, fuchsias, heliotropes, &c., somewhat on the dry side for a few days at the roots —in fact a good dewing will be ample, unless the weather is abnormally hot and dry.

Tomatoes in pots will now demand closer attention. Keep a brisk, warm temperature as the plants come into bloom, and pinch off all unnecessary growths. Water freely when the pots get filled with roots, and as the fruits swell, feed judiciously with weak liquid manure or special fertilizer. As frames become vacated of bedding plants a later batch of tomatoes may be cultivated in these, instead of having them standing empty all summer.

As vines come into bloom keep the house pleasantly warm, and pay careful attention to the ventilation. Tap the vines twice a day to disperse the pollen. Pinch and regulate the growths systematically. Peach trees will now be in full growth and have their final disbudding completed. Train all shoots in such a fashion that no overcrowding takes place and that pruning in autumn is reduced to a minimum. In thinning the fruits remove all the smaller-sized and badly placed ones first. [J. WH.]

Mayweed is the common name applied to certain Composite weeds, which are for the most part annuals, bearing flower-heads like the daisy, with white ray and yellow eye, but with leaves cut up into *numerous fine segments*. Two species are common: (1) Stinking Mayweed, (2) Scentless Mayweed.

Stinking Mayweed, or Stinking Chamomile (*Anthemis Cotula*), common on sandy loams, is an erect branched annual, distinguished by absence of hair, by the strong disagreeable smell emitted by the flower-head when bruised between the fingers, and by the presence of bristles (chaff or bracts) between the yellow flowers. This weed produces flowers and seeds in abundance all summer and autumn, and may become troublesome unless seeding is prevented by hand-pulling or other means. The hands of persons employed in pulling often become blistered by the poison exuding from glands

Stinking Mayweed (*Anthemis Cotula*)

1, Ray floret. 2, Disc floret and scale.

that cover the plant. Stock do not eat Stinking Mayweed.

Scentless Mayweed (*Matricaria inodora*) is another bald annual of light land, which stock do not refuse to eat. The flower-head is large, often 2 in. in diameter, and when bruised between the fingers emits no smell. There are no bristles (chaff) between the yellow flowers of the head. To keep this weed in check, seeding should be prevented as before. Varieties of Scentless Mayweed with the leaves succulent are often found on sands by the sea, and some of these varieties are perennial.

See Chamomile. [A. N. M'A.]

Meadow Fescue. See Fescue Grasses.

Meadow Foxtail. A full description of this grass will be found under its botanical designation Alopecurus.

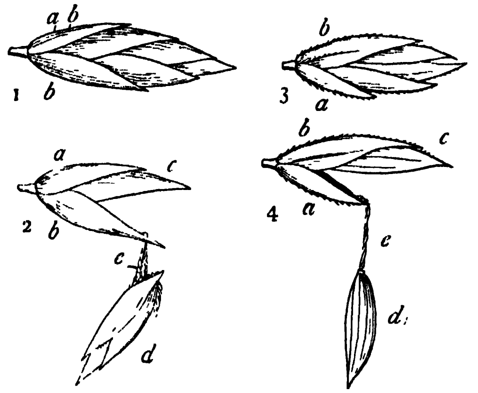
Meadow Grasses, taken strictly, as is here done, include only those grasses that be-

long to the botanical genus Poa. For agricultural purposes, these may conveniently be considered under three heads:—

1. Meadow Grasses for Ordinary Land. The two important species here are: Smooth-stalked Meadow Grass (*Poa pratensis*), and Rough-stalked Meadow Grass (*Poa trivialis*).

2. Water Meadow Grasses for Flooded Land, often called Sweet grasses. In botanical works these are usually separated from the genus Poa and assigned to the separate genus *Glyceria*. The two important species are: Water Meadow Grass, or Water Sweet Grass (*Poa aquatica*, *Glyceria aquatica*, or *Glyceria spectabilis*); and Floating Sweet Grass (*Glyceria fluitans*).

3. Sea Meadow Grasses on sands by the sea and on salt marshes, e.g. *Poa maritima*, of little agricultural importance. These are often assigned to the separate genus *Sclerochloa*.



1, 2, Spikel of Smooth-stalked Meadow Grass (× 6)
1, Spikelet entire. 2, Spikelet broken.
3, 4, Spikelet of Rough-stalked Meadow Grass (× 6)
3, Spikelet entire. 4, Spikelet broken.
a, Lower glume. *b*, Upper glume. *c*, Lower pale. *d*, Broken-off part of spikelet. *e*, Woolly hairs.

Ordinary Meadow Grasses.—These are perennial sole or bottom plants with narrow leaf-blades, folded over one another so that the young shoots are flat. They are easy to identify in a pasture by the small-sized flat shoots with ribless blades. The ear (see Plate) at the end of the straw is a panicle, of pyramidal shape, with slender branches spread out when in flower and when in seed. The spikelets are small, quite flat, without awns, and when ripe break up into from three to five pieces, each piece containing one grain. These pieces when stripped of their hairs are the 'seed' of commerce.

One of the easiest ways to identify the ear of these Meadow Grasses is to break the spikelet by pulling with the fingers; the broken-off part will then hang dangling from the ear, and this because of the presence of a tuft of woolly hairs at the base of each part of the spikelet (see fig., 2 and 4). These woolly hairs (*lana conjunctiva*) are, in fact, a device for attaching the 'seeds' to sheep and other passing animals, so as to secure distribution far and wide. The presence of these hairs necessitates 'stripping' to get commercial seed; otherwise the 'seeds' would not sow separately, but would fall in clumps, matted together by the webs of hair.

Smooth-stalked Meadow Grass (*Poa pratensis*) is an underground-creeping plant with air shoots which yield bottom herbage suitable for spring pasturage. During the first year of growth the amount of herbage is small, but by the second and third years the underground stems have extended and branched out, and produced air shoots in such numbers that all the available ground is covered with a complete sward of grass. When the leaves are allowed to become old, they are so tough that stock reject them. By the month of June, the plant has produced straw and ear. These ear-bearing straws are erect, and rise to the height of a foot or two, and sometimes reach even three feet. After flowering, little additional herbage is produced, but next spring the growth is renewed with vigour. The straw is distinguished by its short knots, by the smoothness of the portion below the ear (the stalk), and by the short blunt ligule of the uppermost leaf.

Smooth-stalked Meadow Grass should only be sown on light sandy lands or on well-drained moorland, to produce sole for spring pasturage and to yield a cut of hay. It is perennial, and forms a complete sward of sole grass; the great defect is poverty of aftermath, and because of this, Crested Dog's-tail, which has the advantage in aftermath, should be used instead, on the better class of soils. The amount of pure germinating seed required to sow a whole acre is about 15 lb.; only 1 or 2 lb. per acre should be used when laying down land under permanent mixtures on dry sandy soils. It is worth noting that the seeds germinate much better in light than in darkness, accordingly the seed should never be covered but only rolled.

Kentucky Blue Grass (*Poa pratensis* var. *latifolia*, Koch) is a variety of Smooth-stalked Meadow Grass, with shorter and broader leaf-blades covered with bluish wax (glaucous).

Rough-stalked Meadow Grass (*Poa trivialis*) has no underground-creeping stems; it bears only tufts of air shoots, which yield early sole herbage like Smooth-stalked Meadow Grass. Some shoots of the tuft do not grow erect, but creep along the surface of the ground, rooting as they go. These creeping shoots branch extensively, and very soon, even in the first year, the ground becomes covered with a complete sward of herbage formed by the interlacing shoots. The leaf-blades of this herbage (ground blades) have edges which are not parallel but taper from the very base, and form a sharp point at the apex of the blade. The blades are much finer and much shorter than those of Smooth-stalked Meadow Grass; they are always tender even when old, and remarkably glossy on the lower surface. The shoots develop straw and ear in abundance a little later than Smooth-stalked Meadow Grass. The ear-bearing straws, which rise to a height of 2 or 3 ft., are distinguished by roughness below the ear, by the long acute ligule of the uppermost leaf, and by the long white cartilaginous knot at the base of the rough leaf-sheath. After flowering, the growth of herbage is quite insignificant, consisting

mainly of diminutive blades a few inches long. In this state the grass is often unrecognized, and regarded as a weed even by those who praise Rough-stalked Meadow Grass as the 'queen of forage plants' because in the first cut it yields a large crop of fodder.

Rough-stalked Meadow Grass should never be sown where the surface is liable to suffer from drought, but on heavy stiff land to produce bottom herbage in spring, or on irrigated land to be cut once a year for hay. The plant is perennial, but very deficient in aftermath; if this defect were absent, Rough-stalked Meadow Grass would rank as one of the very best sole makers for permanent pasture on heavy land. The amount of pure germinating seed for seeding a whole acre is about 15 lb. For permanent mixtures on heavy or wet soils, 1 or 2 lb. of the seed may be used.

Other Meadow Grasses that grow on ordinary land may now be noticed. Annual Meadow Grass (*Poa annua*), common on waste ground, has comparatively broad leaves of tender texture quite readily eaten by stock. All the shoots are fertile, and nothing is left over to continue the growth, so that this is a mere annual grass of little agricultural importance. When the spikelets of the ear are broken, the pieces fall away, for there is no web of hair to entangle them.

Wood Meadow Grass (*Poa nemoralis*) is a perennial shade species often recommended, but too unproductive to be of much value. The straw is easily distinguished by the extremely short black knots, and by the remarkably reduced ligule of the straw-borne leaves. The broken-off portions of the spikelets, as before, have no webs of hair.

Fertile Meadow Grass (*Poa fertilis* or *Poa serotina*) is another perennial species which grows on moist land. It is allied to Wood Meadow Grass, and much more productive, but its seed does not occur in commerce. The straw has greenish knots often with dark lines.

Alpine Meadow Grass (*Poa alpina*) is often an essential and valuable component of mountain pastures. There are two well-marked varieties; the one bears 'seeds' in the ears, the other produces small leaf-buds (bulbils) instead of 'seed'. This second viviparous variety propagates itself by detaching the leaf-buds from the ear; the leaf-bud soon strikes root in moist soil and becomes an independent plant. In mountainous districts the bulbils are simply stripped off the ear and scattered over the ground; in this way, fine pasturage is rapidly obtained at little expense.

WATER MEADOW GRASSES FOR FLOODED LAND.—These are large-bladed grasses with netted leaf-sheaths. The spikelets of the ear are longer than in the terrestrial species, and contain a larger number of flowers. The lower pale for the flower is rounded on the back and blunt-pointed, whereas in the terrestrial species the lower pale is V-shaped (keeled).

Water Meadow Grass, Reed Meadow Grass, or Giant Meadow Grass (*Poa aquatica* or *Glyceria aquatica*) is an aquatic, 5 or 6 ft. high, inhabiting muddy and alluvial-bottomed freshwater lakes, ditches, and the margins of sluggish rivers, where the water does not exceed 5 or 6 ft. in depth. In boggy fens also, this species is common on the parts subject to frequent overflowings. The extensively creeping stout underground stems (rhizomes) fill the ground, and the erect leafy shoots from this rhizome clothe the surface with grassy vegetation. The air shoots appear about the middle of April; they are in flower by the middle of July, and the seed is ripe in August. This plant is a shy seeder—most of the seeds containing no grain (caryopsis). The grain is coal-black, $\frac{3}{4}$ mm. long, and nearly half as broad. So slow is the whole development from 'seed' that it takes at least three years to obtain a passable show of grass when the plan of seeding is adopted. For the rapid production of a meadow the best plan is to dig up old plants, and plant cuttings from these at intervals of 3 ft. By propagating in this way, a good meadow may be produced in two years. Of all British grasses this is the most productive; it is cut twice a year, and is used either as litter or as fodder. The produce should be made up into sheaves so as to dry readily. In the Thames valley and in the Fens, this fodder is considered superior to that from other bog and aquatic plants.

Floating Sweet Grass (*Glyceria fluitans*) is a rapid-growing early perennial with long creeping or floating stems. It is often found in ponds, in swamps, and along the edges of streams. The broad, blunt-pointed leaf-blades float on the surface of the water, and the ear-bearing straws rise to the height of 2 or 3 ft. above the water level. The ear is very characteristic, with cylindrical spikelets often an inch long. In mixture with Fiorin and Rough-stalked Meadow Grass, this plant is useful for binding wet bogland by means of its underground stems, which form quite a matwork of fibrous roots. For such mixtures, cuttings of the Sweet Grass are planted at the rate of five or six thousand per acre. Seed may also be used, at the rate of 4 or 5 lb. per acre, and carefully placed in damp mud, otherwise germination will not occur.

SEA MEADOW GRASSES have short leaves, sometimes almost bristle-like, with V-shaped section. Although certain species are perennial, and greedily eaten by cattle, yet the plants are too diminutive and too unproductive for profitable cultivation. The perennial species are two:—

Sea Meadow Grass (*Poa maritima*, *Glyceria maritima*, or *Sclerochloa maritima*), with a creeping underground stem and succulent bristle-like leaf-blades. This species forms much of the fine turf near the sea. Such turf has sometimes been transplanted for forming bowling greens away from the sea, but without success.

Reflexed Meadow Grass (*Poa distans*, *Glyceria distans*, or *Sclerochloa distans*), not of creeping but of tufted growth. This species bears leaves with blades flatter and broader than those of Sea Meadow Grass. [A. N. M'A.]

Meadow Hay. See art. HAY, CULTIVATION AND GROWTH OF.

Meadow Rue, a large genus of ornamental perennial plants belonging to the Ranunculus order. See THALICTRUM.

Meadow Saffron, a poisonous weed common on many of the light pastures of England. See COLCHICUM.

Meadow Sweet, a plant belonging to the order Rosaceæ, which is an ornament to the garden but a weed in pastures. It is also called Queen of the Meadow. See SPIRÆA.

Meadows, Management of. — The difference between meadows and pastures is, that while meadows are mown, pastures are grazed. Meadows are usually laid up for hay, but, in some cases, they are grazed in alternate years; and even regular pastures may be occasionally mown. The difference is not therefore absolute, but depends upon the use to which the land is put. Meadows are permanent, and it is not usual to speak of clover, sainfoin, or any other arable fields cropped for hay as meadow, even for the time being. They are usually confined to lower and richer soils, and are seen in the greatest perfection in valleys. Productive meadows are generally situated upon deep, moist land capable of resisting drought, and are often hidden with mist after sunset. In many cases they would be too damp for arable cultivation, and in some cases have been temporarily injured in productiveness by drainage. This is due to the disappearance of certain descriptions of herbage, and, for this reason, drainage should be followed up with the application of a 'renovating mixture' of good permanent grass seeds, well harrowed in. This is followed by a dressing of phosphatic and potassic manure, and if these manures are applied, drainage will prove eventually beneficial. When meadows are constantly mown, the exhaustion of the soil is considerable, especially of lime and potash. In most cases the loss is made up by dressings of short and well-rotted dung, and reference to the composition of farmyard manure will show that it is rich in both of these substances, and in every constituent removed by hay. Dung is best applied during the winter, and is then brushed in with bush- or chain-harrows.

The general management of meadows consists in manuring, followed later by an extra chain-harrowing and rolling, and the field is then laid up for hay. Meadows ought not to be grazed after Martinmas in order to allow the grass to develop during winter and obtain a good start in the spring. To continue to keep stock on them through the winter is injurious to the hay crop, as the consequent trampling or poaching the ground renders it uneven for mowing. Meadows are often mown twice, in which case the second crop is known as 'foggage', lattermath, or aftermath. It is optional whether the second growth is mown or fed, and the course adopted is regulated by the requirements of live stock, the weather, and the amount of keep on the farm. Meadows may be used for folding with sheep, and if cake is fed on the land, it answers the same purpose as dunging. One object in managing meadows is to keep the surface level, and the treading of sheep is better for this purpose than cattle-grazing. It is not, however, our object to disparage the use of cattle in any degree, as it is consistent with the best management. Mixed grazing with both classes of stock is often seen on aftermaths. A common complaint with regard to meadows is the persistent growth of miscellaneous herbage of inferior character. Such are Meadow Saffron (*Colchicum autumnale*), which is alleged to cause red-water; Yellow Rattle (*Rhinanthus cristagalli*); Bartsia (*B. Odontites*); Chamomile (*Matricaria Parthenium*); 'Moons' or Ox-eye Daisies (*Chrysanthemum Leucanthemum*); Lady's Smock (*Cardamine pratensis*); Buttercups (*Ranunculus acris*, &c.); Daisies (*Bellis perennis*); Thistles of various kinds; Docks (*Rumex*); Meadow Sweet (*Spiræa Ulmaria*); Rushes (*Juncus conglomeratus*); and many other weeds too numerous even to mention. Clovers and leguminous plants seldom predominate in meadows, and the herbage is generally composed of permanent pasture grasses, such as Timothy, Meadow Fox-tail, Crested Dog's-tail, Cocksfoot, the Fescues, the Poas, &c. Couch, the bane of arable land, is seldom seen in meadows, but various species of Agrostis, among which may be mentioned *stolonifera*, are frequent. No question is more often asked than how to get rid of undesirable plants. The best remedy lies in manuring, and in some cases in drainage; but, of the two, the former is more effective in most cases. Reference to the results obtained at Rothamsted show how amenable herbage is to treatment of the kind. Not only do weeds disappear under liberal management, but the predominance of certain species of grasses and of clovers seems to depend largely upon the fertilizers used. Any manure which stimulates the growth of the grasses proper tends to stifle other forms of herbage, and manures of a nitrogenous character are especially powerful in this respect. On the other hand, phosphatic and potassic manures encourage the growth of white clover and leguminous herbage generally. A well-adjusted dressing of mineral and nitrogenous constituents is sure to produce an excellent effect; the great improvement in certain cases caused by applications of basic slag might be cited. It is also well to remember that 'dirt' of all kinds contains manurial ingredients well adapted for encouraging the growth of grass. Although the percentage composition is of a low order, it is compensated for by the bulk of the material employed, which is in terms of tons per acre instead of in hundredweights. Lime and chalk are both beneficial to meadows, and sweeten the herbage. The management of water meadows, which form an important part of the subject of meadows, is dealt with in the article on WATER MEADOWS. They are restricted in area and in locality, but afford the best example of continuous mowing from year to year, without the application of any kind of manure, and without any diminution of yield. Lastly, with reference to the eradication of weeds, repeated mowing of rushes, thistles, and other intruders, especially before seeding, is beneficial, and if persevered in, will be at least successful in reducing their number. [J. WR.]

Meadows, Manuring of. — Meadows naturally divide themselves into two classes in their manurial needs: (1) those on which natural grasses, clovers, and other leguminous herb-

age are growing; (2) those which may be looked upon as grass meadows, such as meadows sown with Timothy or other grass seeds only, or meadows which consist of natural grasses only, and from which clovers and allied plants have disappeared.

With regard to the first class, experiments at Cockle Park, Northumberland, and at other centres distinctly indicate that the quality of the hay is considerably better when the manuring encourages the development of natural clover and allied plants. In the long run, also, even if only quantity of hay is considered, manuring of this character is found to be most profitable, provided there are clover plants in the herbage. Phosphatic manures are of the greatest importance for meadows, with the addition of a potash manure if the soil is of a light character and deficient in potash. On Palace Leas meadow-hay field at Cockle Park, on a clay loam soil, phosphatic and potash manures, applied annually for ten years, left at the end of that time the equivalent of about 375 lb. of nitrogen in the soil per acre more than when the same manures were applied with the addition of 150 lb. sulphate of ammonia annually. It was found at the end of the ten years that there was 23·9 per cent of clover and allied plants in the herbage where phosphatic and potash manures only were applied, and that there was only 6·5 per cent of these plants in the herbage where sulphate of ammonia was added to the foregoing manures. During the ten years the average crop of hay produced was 26½ cwt. an acre from the phosphatic and potash manures, and 31½ cwt. an acre from the same manures with the addition of sulphate of ammonia. The few hundredweights more hay from the sulphate of ammonia did not pay the cost of this manure, as at the end of this time the net gain per acre was 2*s.* 4*d.* annually from the phosphatic and potash manures, while there was a loss of 1*s.* 10*d.* when sulphate of ammonia was added to them. The feeding qualities of the hay were carefully tested by experiment, and when these were taken into account the net gain per acre was 20*s.* 3*d.* from the phosphatic and potash manures, while this was reduced to 6*s.* 9*d.* an acre when sulphate of ammonia was added. These results have been fully confirmed elsewhere.

On meadows where clover plants are deficient, it is probable that a small seeding of *wild* white clover would be of considerable advantage. For the manuring of such meadows phosphatic manures take the chief place. For meadows on heavy or peaty soils, and in fact for meadows on all classes of soils except those containing lime, basic slag usually gives good results. To begin with, a dressing of 10 cwt. an acre (containing 200 lb. phosphoric acid) might be applied, or instead of this about 8½ cwt. an acre of finely ground bone meal might be used, although this latter is likely to be slower in its action, as well as more costly. On the lighter classes of soils it will probably be advantageous to add 1 to 2 cwt. muriate of potash per acre. This could be followed by half the foregoing quantities of phosphatic and potash manures every three years. All these dressings should be applied in the autumn or early winter, and always after the herbage has been closely eaten down, while a good harrowing with heavy harrows at the same time, if the surface is rough, would make them more effective. Experiments on all classes of soils, even on peaty soils, indicate that lime is not a useful addition to the foregoing manures, especially if basic slag is used. The latter probably owes its good effects considerably to the fine condition in which the lime is contained in the slag.

If dung is available, the Cockle Park experiments show that excellent-quality hay can be produced by applying about 10 tons dung and 5 cwt. basic slag per acre every third year. Dung is poor in phosphates and lime, and slag has proved to be an excellent complement to dung in supplying these ingredients. This plan of manuring has given good bulk and at the same time excellent quality of herbage.

For meadows of the second class a different system of manuring is required. As clover herbage is practically not present, the collection of nitrogen from the air takes place only to a small extent by means of the roots of these plants. For Timothy or other grass meadows, therefore, nitrogenous manures should be liberally used. A useful plan of manuring for such meadows is to apply about 12 tons dung an acre every third year and a dressing like the following per acre in intervening years: ¾ cwt. nitrate of soda, ¾ cwt. sulphate of ammonia, 1½ cwt. superphosphate, and 1½ cwt. basic slag. The superphosphate and basic slag should be applied in the autumn or early winter, and the nitrogenous manures in the spring. If artificial manures only are used, the foregoing dressings could be applied annually with the addition of 2 or 3 cwt. kainit on light soils.

Meadows frequently become coarse and benty in the bottom, and when they are in this condition manures are not nearly so effective. The aftermath and winter foggage should always be as closely eaten down by cattle as possible, and the hay should always be mown before the grasses are in full flower. Such early mowing not only secures much more nutritive hay, but gives much more growth of aftermath, and healthier growth in succeeding years, as the meadow plants lose much of their vitality when allowed to become too mature before being mown. [D. A. G.]

Meal Moth, a moth whose caterpillars are destructive in stores and granaries. See Asopia.

Meals.—The term 'meal' is variably applied in agriculture to either a single material or grain which is also used in the unbroken or unground condition, or to a mixture of different materials which are all ground into the form of meal. Thus, while one employs on the farm, in the whole state, such grains as wheat, barley, oats, beans, peas, maize, &c., one has also in common use wheat meal, barley meal, bean meal, maize meal, &c. Similarly, there is decorticated cotton cake and decorticated cotton-cake meal, while there is another large class of feeding materials which consist of a mixture of ingredients all ground into meal and known under such general names as 'feeding meal', 'fattening meal', 'dairy

meal', 'calf meal', &c. Nor does the application of the term 'meal' always imply that the meal is merely the grain or other material ground fine, but special meanings attach in some cases according to commercial custom or industrial use. Thus, while wheat meal or barley meal may mean the whole grain ground into meal, oat meal, because of its employment as a human diet, is a different thing to ground oats, the husk or 'shude' being separated in the case of the former. Rice, again, is never used whole on the farm, but the outer husk or 'shude' is first removed and then the inner coat of the grain, this latter being ground into meal and sold for cattle as 'rice meal'. It is not unusual, indeed, with many grains, to partly remove the outer coating and so get a finer meal; while, on the other hand, it may be added, cases have been known to occur in which the husk, after removal, has been ground up and incorporated with meal to which it did not originally belong. Altogether, the definition of 'meal' is a very uncertain one, and this constitutes an objection to the purchase of meals. There is nothing to enforce the extent to which the husk shall be removed, and 'trade custom' largely prevails in such matters.

Yet again, a meal may include a grain or material which has been treated not only mechanically but also chemically. Such is 'rape meal', the oil of which has been extracted by bisulphide of carbon or other chemical solvent. 'Linseed meal', though this has now gone out of use, was ground linseed with the oil extracted by chemical means. It was known in America as 'Cleveland meal'.

The term 'meal' is not restricted to feedingstuffs, but applies also to manurial substances, *e.g.* 'bone meal', 'meat meal', 'slag meal'; but in these cases it simply means the material finely ground and without further alteration. The remaining remarks in this article will therefore be confined to the case of feedingstuffs.

The question at once arises: What is the benefit, if any, of having a feeding material in the form of a meal, and what disadvantages, if any, attend its employment in this form? It may be taken, in the first place, that the preparing of grain, &c., in the ground state implies a more complete utilization of it by reason of it being presented to the animal in a form in which it is more easily attacked by the solvent juices of the stomach, intestines, &c., thereby becoming more easily digested. When whole grain is given, there is always a tendency for some of it to pass through the animal undigested, whereas if finely ground it might have been more fully utilized. This is seen in the case of maize in particular. Also, in making up a mixed diet, it is much more easy to get even distribution of the materials if these be given in the form of meal. Whole beans, peas, maize, &c., would fall through a mixture of them with chaff and collect at the bottom of the manger, whereas, if in meal, they would be spread more evenly through the mass. On the other hand, it is not to be questioned that some stock like to crush up their food—a horse likes to grind its oats for itself, a bullock or cow likes cake given in small pieces rather than as meal. A pig, on the other hand, must have everything presented to it in meal form, or so as to be readily reducible to meal. It has been found by experience, too, that food is not always most acceptable if all mixed up together, but a feed of corn or of cake is frequently given by itself at stated hours. One has to be guided also by the conditions under which food is given, for, while a meal may do quite well and be more economically used to cattle feeding under cover, yet, when stock are out at grass or sheep are feeding in the open, the use of a meal is attended by considerable waste, and by a clogging together when rain falls on it.

On one point, however, there is no uncertainty, and this is that, as a rule, the purchase of meal as such is attended with risk, both as regards the condition and the genuineness of the material composing it. It is far safer for the farmer to use his own grain, or to buy beans, peas, maize, &c., whole and grind them himself on his farm, than for him to depend on purchased meal. It is not too much to say that fully one-half of the cases of adulteration of feedingstuffs takes place with purchased meals. Wheat meal, barley meal, sharps, middlings, bean meal, maize meal, and even rice meal are 'happy hunting-grounds' for the adulterator; and such cases as have been recorded of sawdust and gypsum being mixed with wheat and barley meal, or of rice husks mixed with maize meal or bean meal, would never have occurred if the purchaser had obtained the whole grain and ground it himself on his farm. When the whole grain is purchased it can be seen very fairly whether it is free or not from foreign matters, and also whether it is in good sound condition. Too often, it is to be feared, when grain or other feeding material or a feeding cake has been damaged or is not in fresh condition, it is ground into meal and so used up with other materials. This constitutes one of the great objections to compound cakes and meals—one cannot tell whether the materials of which they are composed were all in good and sound condition. Similarly, impurities which could be detected by their appearance in the case of whole grain, can be ground up and rendered indiscernible to the non-expert eye, and often, indeed, can only be detected by the agricultural chemist and with the help of the microscope. Of such nature is the occurrence, in bean meal, of the poisonous Java beans, or of *lathyrus*, or, again, of castor-oil bean.

It must not be supposed, however, that meals are without their advantages. Some of these have been mentioned already, and, though there is no occasion for grinding linseed cakes and undecorticated cotton cakes into meal, it may be otherwise with the decorticated cotton cake. This, unfortunately, is frequently very hard, and not only is it difficult to break into pieces, but it is not advisable to give it to stock unless it be broken small. The trouble is increased when, through carelessness in making, the cake contains hard dark-coloured lumps, caused by the meal collecting together in the 'kettles' in which the seed is steamed before undergoing

pressure. When this is the case, it is a decided advantage to grind up such cakes into meal, and this is frequently done by the manufacturer.

COMPOUND MEALS.—The advantages and disadvantages already mentioned apply with equal or greater force to meals made, not from one grain or material only, but from a mixture of these. Constant vigilance has, accordingly, to be exercised here. It is not enough that a guarantee (as required by the Fertilizers and Feedingstuffs Act) of oil and albuminoids be given, but one needs to know that the ingredients are such as are suitable for the purpose, and that they are in good and sound condition. It is hard to ascertain this in the case of compound meals. A guarantee of oil and albuminoids, indeed, is often of little value, and these compound meals may well be more valuable because of the starchy bodies and the other carbohydrates that they contain than for their oil and albuminoids. This guarantee, further, leaves out of account altogether what the source of the oil and the albuminoids is, and that often is the most important consideration. A compound meal having its oil derived from linseed is of very different value to one the oil of which is derived from rice or maize or similar grain. The Act, however, takes no account of these differences, any more than it does of the presence of weed seeds. So long as it cannot be said that the meal contains anything absolutely worthless for feeding purposes or something actually injurious to stock, nothing can be done; and a guarantee of oil and albuminoids that 'reads' high may be giver and yet the meal (or cake) be made from second-rate or inferior ingredients. If, however, a meal be satisfactory in these respects, there are advantages attending the feeding of a meal composed of not one material only, but forming in itself a mixed diet. The great gain in the farmer's view is that they save him the trouble of making up a diet himself, such a diet being presented in a form ready to hand. Often, too, the ingredients composing the meals have been 'cooked' beforehand and rendered more easy of digestion, or they are compounded with sweetening and appetizing substances such as locust meal, molasses, condiments, and spice.

The purposes which such foods probably serve best are that they are useful in inducing animals to eat more bulky food, like chaff, &c., than they otherwise would, and also in tempting animals when they are 'off their feed'. A little of some spicy or sweet-tasting meal or cake may induce animals to eat when they are 'out of sorts', and hay or chaff that is not in the best condition may be made more palatable to animals by the use of such meals. Similarly, when cattle are being 'finished off', some appetizing meal or cake will induce them to feed more freely and to put flesh on more rapidly.

Many such meals are compounded with great care and deserve the good name they have obtained, but many others are very unsatisfactory and are sold at prices much beyond their value. Hence one may rightly regard with a certain amount of caution compound meals sold under names such as 'feeding meal', 'fattening meal', 'dairy meal', 'calf meal', &c. [J. A. V.]

Mealy Bugs.—Three kinds of Mealy Bugs are found attacking plants under glass in this country. Two, known respectively as *Dactylopius citri* and *D. longispinus*, are found on the wood and foliage, blossom and fruit; and the third, *Ripersia terrestris*, on the roots of palms, &c. Mealy Bugs are Coccidæ or Scale Insects which have a naked body covered with meal and waxy threads, and, unlike the Mussel Scale or Rose Scale, are freely movable insects. The first two are especially harmful to vines. The commoner species (*D. citri*) has also been found out-of-doors on ivy-clad walls at Kew, &c., but it will not thrive in such localities. The two species of *Dactylopius* can easily be distinguished by *D. longispinus* having very long processes, especially at the anal end, whilst *D. citri* has them all short. In length they vary from $\frac{1}{12}$ to $\frac{1}{8}$ in. They shelter in crevices on the plant, but owing to their white woolly secretions are easily detected. They breed under glass all the year round. The females are quite wingless, but the males are winged, and are of a reddish-brown colour covered with meal, the abdomen with two long caudal filaments, and they have two iridescent blue wings. The males occur only in hot summer weather. Mealy Bugs damage the plants they feed upon by sucking out the sap, and also by spoiling the fruit and foliage by fouling it with their soft, mealy bodies and their excrement.

Treatment consists of painting the attacked vines or plants, where the insects are seen, with methylated spirits with a soft brush, or of fumigating in the case of vineries. The houses are best fumigated when the vines are dormant, and special apparatus should be employed so as to ensure safety to those carrying out the process, and an even distribution of the fumigant. Hydrocyanic acid gas is the best remedy, but it should be used twice, at an interval of a week or ten days, in case any eggs have escaped the first fumigation.

The proportions to use in vineries are as follows: For every 100 cu. ft. of space, $\frac{3}{8}$ to $\frac{1}{4}$ oz. of cyanide of potassium, or $\frac{1}{3}$ to $\frac{1}{5}$ oz. of sodium cyanide, and for each ounce of cyanide one liquid ounce of sulphuric acid previously diluted with 4 oz. of water. For dormant vines the greater strength may be used, but not when they are in leaf. Vines should not be fumigated when in bloom or before the grapes commence to ripen (see art. FUMIGATION).

The Root Mealy Bug (*Ripersia terrestris*) attacks the roots of palms, ferns, and stephanotis, &c. The Maidenhair Fern seems especially liable to its ravages. They secrete great quantities of white meal and wool, so are readily detected. Eggs are laid amongst the rootlets and often enclosed together in masses of woolly fibres. These Mealy Bugs, by sucking at the roots, cause the foliage to turn brown, and the whole plant may die under their attack. They mostly live on the outer rootlets, but if the fibre is open they may pass some little way in.

Treatment consists of (1) dipping the plant taken from the pot in warm soft soap and water for two minutes; or (2) spraying the roots all around with bisulphide of carbon by means

of a scent fumigator, and then put the plant back in the pot, which has been scalded; this should be done again in two days.

Treated ferns and palms should be kept in the dark for a few days after the treatment. [F. V. T.]

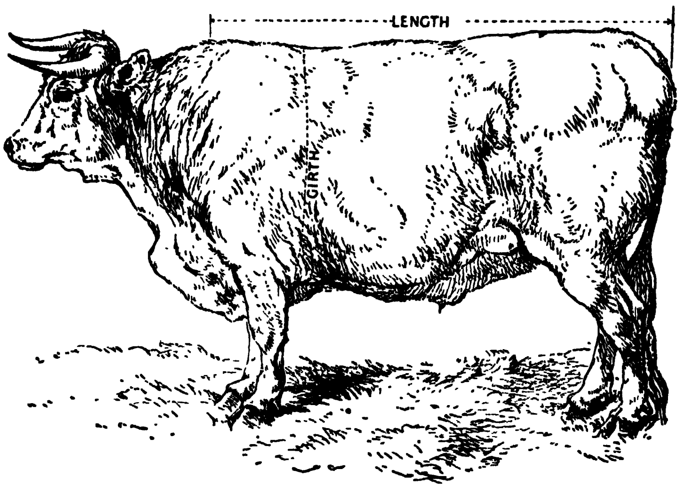
Mealy Plum Aphis (*Hyalopterus pruni*).—This aphis occurs on all kinds of plums, and can at once be told by the dense green mealy mass under the leaves. The leaves, although they may be completely covered beneath with the insect in all stages, seldom curl up as is the case with the Leaf-curling Aphis (*Aphis pruni*). The damage done is not so much to the foliage as to the fruit, for they secrete great quantities of a very sticky honey-dew, and this falls on to the fruit and soon becomes covered with excrement and black fungus. It occurs in Scotland and Ireland in some districts, but is especially harmful in Worcestershire and Herefordshire, and to some extent in all fruit-growing districts in England.

The Mealy Aphis appears in June and July, and continues upon the leaves on to September. Winged broods keep appearing, and fly from tree to tree in summer. In early autumn they leave the plums. Where they go to is not for certain known, but it is assumed they winter on reeds, &c., and return to the plums in summer. Fresh evidence that this is the same as *Hyalopterus arundinis*—the reed aphis—has lately been obtained. It has also been found on the peach and the nectarine, and in Italy on vines. It also occurs on wild prunes. In some years much ripening fruit is rendered unfit for market by its persistent attack.

Treatment.—As soon as their presence is detected, and the migration to the plum is seen to have ceased by the absence of winged females, the trees should be well washed with paraffin emulsion in which 1 lb. of liver of sulphur to every 100 gal. of wash is incorporated. This latter is necessary to kill this aphis. It is also essential that the wash be put on with force and plenty of it, not as a fine spray. [F. V. T.]

Measles.—The pig is the most frequent subject of measles, but the ox, and more rarely the sheep, are known to have them, as well as the dog and cat, and man himself (this parasitic disease being, of course, quite different from ordinary measles). The cysts whose presence cause this disease are referred to as bladderworms, and follow the rule in regard to all tapeworms in their intermediate existence being passed in a cyst or bladder (see arts. GID and CYSTS). The bladders in all cases contain the immature tapeworm of the variety to which they belong, unless or until they have undergone degenerative changes which make them unrecognizable. The pig measle is caused by the *Cysticercus cellulosæ*, which is the bladderworm stage of the human tapeworm, *Tænia solium*, or *Tænia armata*. The pig becomes measled by the ingestion of the eggs of the tapeworm evacuated by man. Man acquires tapeworm by eating pork containing the bladderworm (*Cysticercus*). The striated or voluntary muscles are the natural habitat of the measle, whether in pigs or ruminants, or man, but they are not infrequently found in the substance of the heart and other organs in such numbers as to preclude the idea of being wanderers. Measly pork and beef is rejected by the inspectors of markets as dangerous, and unfit for human food. The life-history or cycle of the parasite points to the means of prevention by proper sanitary laws. Measles in this country is now extremely rare. See BLADDERWORMS and CYSTICERCUS. [H. L.]

Measurement of Cattle (Estimation of Weight).—Prior to the more



general introduction of the cattle weighbridge, methods of estimating the weights of cattle by calculations based on measurement were somewhat extensively adopted, and they are still sometimes employed. The method in general use is to measure the length of the animal in a straight line along the back, from the point where the neck joins the shoulder to the point at the tail head from which a plumbline will include the whole of the buttocks; and also to measure the girth of the body just behind the shoulder. The girth measurement is squared, and multiplied by that of the length, and the product is again multiplied by a figure which gives the carcass or dead weight of the animal in stones of 14 lb. The latter figure has to be varied, however, according to the breed, the age, the sex, and the condition and form of the animal, in order to obtain accurate results, and some skill is therefore required in the application of the rule.

It is obvious that a calculation, affecting the whole carcass of an animal, which is based on the girth, can only be applicable with even

approximate accuracy to animals so similar in form that the other parts of the carcass have a regular proportionate size to the depth and width of the animal body at the part where the girth is measured. A certain uniformity of shape may be found to prevail among the animals of any one breed, but this uniformity obviously does not extend equally to animals of other breeds, and hence a difference in the method of calculation must be employed to meet this irregularity. To obtain any approach to absolute accuracy different scales of figures would require to be employed for each of a large number of breeds, but data are not available for the construction of such an elaborate series of scales. Mr. John Ewart of Newcastle-on-Tyne, who gave much attention to this subject, and who introduced an improved gauge to enable farmers to make their calculations with ease, found in practice that sufficient accuracy could be obtained by dividing cattle of the common breeds into three classes. The first class included animals of the best fattening breeds, such as the Hereford and the Shorthorn; Class III those of the rougher and least symmetrically formed breeds; and Class II intermediate breeds, such as the Red Polls, Longhorns, and Ayrshires. Such a classification is obviously incomplete, and could be advantageously extended and improved were sufficient data available.

But a still more important condition to be taken into account in calculating the weight of the animal from its measurement, is to be found in the *condition* or state of fatness at the time the girth is taken; and as this applies alike to animals of all breeds, a more elaborate subdivision based on *condition* has been found practicable, which, if properly made, ensures great accuracy in the calculation. Mr. Ewart's multipliers for bullocks and heifers, in which animals are divided into three classes according to breed, and again into five subdivisions according to the relative degrees of fatness, is shown in the following table:—

Condition of Animal at time of Measurement.	Class I. Best Fattening Breeds of Symmetrical Form.	Class II. Intermediate Breeds.	Class III. Rough and Coarse Animals of Unsymmetrical Form.
Half fat	·23	·225	·22
Moderately fat .	·24	·24	·23
Prime fat	·25	·25	·24
Very fat . . .	·262	·26	
Extraordinarily fat	·275	·27	·25

The method of calculation may be easily understood from the following example. A bullock adjudged to belong to Class II and to be in prime fat condition is found to have a length of 5 ft. and a girth of $6\frac{1}{2}$ or 6·50 ft. Then

$$6{\cdot}50 \times 6{\cdot}50 = 42{\cdot}25;\ 42{\cdot}25 \times 5 = 211{\cdot}25;$$
$$211{\cdot}25 \times {\cdot}25 = 52{\cdot}8125.$$

The carcass weight of the animal is therefore 52·8125 st. of 14 lb., or 52 st. 11 lb. Bulls weigh more heavily in proportion to measurement, and for them an addition of about 8 per cent may be made to the above figures. A similar method of calculating weight is also applicable to sheep and pigs. [R. P. W.]

Measurement of Land, Stacks, &c. See MENSURATION and SURVEYING.

Measurement of Timber. See TIMBER, MEASUREMENT OF.

Measures. See WEIGHTS AND MEASURES, METRIC SYSTEM, MARKETING OF FARM PRODUCE.

Meat.—Meat as generally understood may comprise many different varieties of food, and may include anything that is considered fit for eating; and in our scheme of dietetics there are quite a large number of animals, birds, fish, and vegetables which come under this designation—so far as human food is concerned. When we speak of 'meat', however, we generally refer to the commoner kinds of flesh foods which enter so extensively into our economy. Meat, therefore, may be described as the flesh of mammals, or of animals which belong to the higher vertebrates, being such as are possessed of mammæ or teats which enable them to suckle their young. Such animals are the bovine, sheep, and pig species, and it is from these three that the greatest bulk of our meat supply is derived. There are some countries where horse flesh is now commonly used, and in France and Germany, especially, horse meat forms quite a large part of the nation's dietary.

Beef is derived from cattle, and for food purposes should be taken from the dressed carcasses of healthy animals only. The edible portions consist of all the muscular and fatty tissues, and these may be prepared for food in certain 'cuts' or joints, according to local custom.

When the animal is slaughtered it is dressed by the removal of the offal or internal organs, the four legs are severed at the knee and thigh joints, and the carcass is hung until it is cool. If the meat is cooked while it is warm, immediately after slaughter, it is tender and easily assimilated; but if cooked after being hung for a few hours only, it will be tough, owing to the chemical change which has taken place in the tissues and the meat juices. This stiffening (*rigor mortis*) is followed by a relaxation or softening which takes place some hours after, and the tenderness of the meat is then increased by keeping it in suitable conditions for a period of some days. Putrefaction is set up at high temperatures, and hence these conditions have given rise to methods of keeping meat by means of cooling appliances (see art. REFRIGERATION).

Frozen and chilled meat are largely consumed in the United Kingdom. See art. FROZEN MEAT.

Meat products are very numerous, and altogether something over a hundred different articles of commerce are prepared from the carcasses of bullocks. In the United States, Argentina, and Australasia, the branch of the meat industry dealing with the by-products has received much attention, nothing being allowed to go to waste, and many products used in the arts and sciences are thus made available.

Mutton is derived from sheep, and consists of the muscular tissues or flesh of the carcasses, from which the blood, skin, and intestinal offal have been removed. It differs very materially from beef in its chemical composition, containing a smaller quantity of albuminoids, and in the case of fat sheep five times the quantity of fat. Ordinary sheep contain about the same percentage of fat and water as beef.

Pork is the flesh of pigs which have been dressed and cleansed, and while it is used largely in the fresh state, it is more extensively utilized for the manufacture of hams and bacon (see art. BACON). It is also much used for the making of sausages, the quantity of which produced by the large manufacturing firms, in the United Kingdom alone, amounts to about 13,500 tons per annum.

Meats generally, which are derived from these three sources, are classified as (1) fresh meat, (2) frozen meat, (3) chilled meat, (4) pickled meats, (5) canned meats; and there are many subsidiary products, such as fat, oleo, lard, meat extracts, which are all obtained from the carcasses of either one or the other animal. There are also hides, sheepskins, hoofs, horns, blood, bones, gelatine, which are handled by separate trades. In a smaller way there are many articles produced involving scientific knowledge, such as pepsin, meat peptones, blood albumin, pancreatin powder, glycerine, and others of a like character; and the manufacture of these has during recent years given rise to the establishment of many industries in different countries, which convert into commodities of value what, not so long ago, was regarded as being worthless. See also arts. BEEF, MUTTON, &c.

[L. M. D.]

Meat, Frozen. See art. FROZEN MEAT.

Meat, Pickling of.—The pickling of meat is one of the methods used for preserving it, but the action which takes place in reality converts the meat into a totally different product. The process of pickling is simply that of putting any kind of meat into a saturated solution of common salt, and by this means some of the juices of the meat are displaced with the salt solution, and the meat preserved for a period considerably longer than it could possibly be kept in the fresh state. The transference of the meat juices from the meat to the pickle takes away from the meat a certain amount of nourishment; it thus results that pickled meats of all kinds are less nutritious than those that are fresh.

The 'art of pickling' is, however, a very old one, and has existed in all civilized countries from the earliest times. It is only within recent years that it has been reduced to anything like methodical processes, and even at the present day there is room for investigation as to how the peculiar flavours produced in certain localities in pickled meats are derived. Meat which has to be pickled may either be of beef or pork, but it is seldom that mutton is pickled. Sometimes, however, legs of venison are treated in this way. The general conditions necessary for pickling are, that the meat itself should be quite fresh. It is a mistake to suppose that when meat has become slightly tainted it will thereby be preserved by being thrown into pickle. The germs of putrefaction are not destroyed by a solution of salt, and therefore the pickle should be kept entirely free from these. The only way to do this, is to see that the meat is fresh to begin with. The particular parts of beef or pork that are most frequently pickled are the fleshy portions, such as the rump in the case of beef, and the leg in the case of pork. In the west of Scotland, however, bacon is also pickled, or as they call it 'cured', by the 'wet process'. In every case, however, the conditions of successful curing are the same, and the pickle which is used is uniform throughout. The conditions of curing are that the process should be carried on in a perfectly clean cool cellar or outhouse which is shaded. It should be arranged that the place where the curing has to be done should be a cleanly spot and should be free from windows, but should have ventilation. These rules would apply not only to the small curing cellar on a farm, but to the large apartment of a bacon-curing factory.

The pickle to be used should be made from 55 lb. salt, 5 lb. saltpetre, 5 lb. pure cane sugar, 5 lb. dry antiseptic or boron preservative. This quantity should be made up to 20 gal. with clean water, and boiled until quite clear, and should be allowed to cool to the same temperature as the room in which it is going to be used. When finished it should test 100° on the salinometer, or in a rough-and-ready way it should float a large potato. This pickle may be improved or altered to suit local taste or tradition, and in many parts it is common to add such flavouring matters as peppercorns, Jamaica pepper, coriander seeds, laurel leaves, and juniper berries; but there is no fixed rule in connection with these matters, it being for the most part entirely a question of taste. The simple pickle as given in the recipe is all that is required.

As in the curing of hams or bacon, so in the pickling, there is considerable amount of judgment necessary, and the size of the piece of meat or pork to be cured has a great deal to do with the length of time it may remain in the pickle. A very good rule, however, is that pieces of meat or hams up to 20 lb. in weight should be allowed one day in pickle for each pound in weight, and this will give a mild cure. A salty cure would be obtained by giving the meats two days for every pound in weight. These figures, however, would be modified if the meats are pumped with the pickle, as is now generally the case; a pickle pump being used to inject the pickle right into the centre of the meats, before they are placed in the curing solution. This bringing of the pickle directly into contact with the interior tissues of the meat shortens the cure considerably.

The same pickle and the same processes may be used for curing tongues, heads, houghs, and other secondary offal from pigs. Ox tongues also may be thus cured; but these various products being different in size from the average pieces of meat usually handled, are only put in to cure for from four to five days, and are then taken out of the pickle and drained. In the curing of ox tongues it is usual to 'vein' the

tongues, that is to say, to cut the main arteries which lie along each side of the base of the tongue and insert the needle of the pickle pump into these veins, and then pump pickle right through the tongues. This is a wonderful safeguard against loss.

When the various goods are cured they should be taken out of the pickle and drained on a slab until the excess of liquid has run away, after which they should be hung up to dry, and will then be ready for use. See also PICKLING and PICKLING SOLUTIONS. [L. M. D.]

Meat, Preservation of. — By the preservation of meat is meant the arrest of putrefaction or decay. The complicated chemical changes summed up in the word putrefaction are changes by which complex animal substances of the type of albumin become broken down into simpler and still simpler substances, generally ending as ammonia, carbonic acid, water, and the like; and it is now known that the initiative in such a breakdown series is given by certain bacteria of putrefaction. Not only do these bacteria themselves prove harmful when taken into the system along with meat, but by their action upon albuminous materials they give rise to a series of poisonous substances called ptomaines, which are capable of producing irritant and even fatal effects, apart altogether from the presence of the bacteria which gave rise to them. Meat preservation has thus come to be a branch of applied bacteriology, and is governed by the general laws affecting the life, growth, and death of bacteria.

Preservation processes thus aim at killing, or at least paralysing, germs already present in meat, by the use of germicides or antiseptics respectively, and they aim also at excluding newcomers, either by excluding air, by which most of these invading germs are carried, or by rendering the meat uninhabitable, owing to the withdrawal of water or other substances essential to germ life, or to the addition of some actual germicide or antiseptic. All bacteria require a certain degree of heat and moisture and suitable food, usually of a nitrogenous nature. Under ordinary conditions their limits of temperature are narrow, and the most of them are killed at a temperature above 73° C. or 180° F., and rendered harmless at least by exposure to the cold of freezing. When, however, bacteria have formed spores, these have a very high resisting power, especially to cold; not only is ordinary freezing powerless to kill them, but they have retained their vitality even after being exposed to the incredible cold of liquid air and liquid hydrogen. Even at temperatures much higher than boiling-point (100° C., 212° F.) they are still alive, and it requires the intermittent application of heat to destroy them, giving the spores time to develop into the ordinary and less hardy form.

It will at once appear that refrigerating processes cannot be trusted to sterilize meat; they are, however, useful for suspending bacterial action, and thus overcoming conditions of time and distance by postponing the decay of meat in transit or store. Preservation at high temperatures is illustrated in canning meat and fruits, though there it is combined with exclusion of air. The meat is packed into a can, covered by a lid with a small blowhole, and cooked at a little above boiling-point of water till all traces of steam disappear, then the temperature is sharply raised to about 270° F., and after a few minutes of this the blowhole is closed by a drop of solder, thus rendering the can airtight. When the contents cool down, the can should be slightly concave, owing to the formation of a partial vacuum; a convex or even plane lid would induce suspicions of 'blowing', the formation of putrefactive gases. Obviously this process is applicable only to small quantities.

Desiccation or drying is the process adopted by nature in preserving fruits and seeds, and it has been used with fair success in connection with small quantities of meat, and indeed forms the basis of all 'meat-powders'. Practically, however, all modern processes are chemical, employing various germicides or antiseptics, which may be solids, liquids, or gases. It stands to reason that a preservative must be non-poisonous and indeed harmless from the physiological standpoint, must not affect the digestibility of the meat, or, if possible, its flavour and appearance. Formerly the favourite preservative was salt or saltpetre, but in addition to their physiological action they caused serious loss of the meat juices, especially when administered as pickles or injections (see BACON, CURING OF), and now they have been largely displaced by boracic acid, borax, or boracic compounds. The battle about borax and its physiological effects has been drawn, or, to vary the metaphor, the trial has resulted in a verdict of 'not proven'. Borax is soluble in cold water in the proportion of 1 in 22, but boiling water dissolves twice its own weight of borax, and for preserving purposes $\frac{1}{2}$ to $\frac{3}{4}$ per cent of borax is equal to 4 or 5 per cent of salt, while loss of juice by osmosis is practically *nil*. Another preservative is calcium bisulphite, made by passing sulphur dioxide gas through quicklime, in the same way that chlorinated lime and eau-de-Javelle are made for bleaching purposes. It is used for dressing bacon, and is sponged or painted over the surface in proportions of 1 of bisulphite to 3 of water. Sodium fluoride solution has also been used.

A very interesting process, and one capable of much improvement, is that of internal preserving, by injecting the bloodvessels with an antiseptic solution shortly after death. Garmel, who discovered this, used aluminium chloride as the injecting fluid, but his work has not been developed on the commercial side.

All the above preservatives have been solids or liquids, but more recently use has been made of gases or other volatile vapours, which not only condense on the surface, forming an effectual screen against bacteria, but actually penetrate to a slight depth, giving greater security. The first of these methods is that of Isidore Hislaire of Brussels, who employs a volatile carbon compound in the form of pastilles. The food is placed in an air-tight chamber, along with one or more of these pastilles, and the temperature is kept at 170° F. for fifteen to thirty minutes. On being removed, the meat is found to be coated with a

thin film of 'carbon', it keeps indefinitely, and loses this film on being cooked. The pastilles are about the size of a sixpence but four times as thick, they contain ten ingredients, and at 170° F. sublime into vapour, leaving only the barest perceptible residue; at higher temperatures they burn or char emitting no gas, so that it is necessary to maintain the proper temperature. The vapour, a carbon compound, has a pungent smell, and when inhaled produces watering of the eyes and severe headache, so that the danger of accidental asphyxia is remote. The food is left in the chamber for fifteen to thirty minutes, depending on its amount, and it comes out unaltered in colour, appearance, and taste, while, as far as experiments go, its digestibility is not affected. The cost of preserving 2000 lb. of meat is three francs (2*s.* 6*d.*), and not only are putrefactive germs killed in fifteen minutes, but those of enteric fever, cholera, pneumonia, suppuration, and anthrax, even the spores of this last succumbing. The process is applicable to milk, eggs, &c., and has even been used for sterilizing linen in hospitals. For a very lucid account of the Hislaire process see Chambers's Journal, June 13, 1908, No. 550 (vol. 1908, p. 439).

[J. K.]

Meat Inspection.—The consumption of meat has so greatly increased lately, due to the importation of vast quantities of this foodstuff, that public health authorities are giving more attention to the purity of the supply. Yet meat inspection as carried out in Great Britain, compared with the systems adopted in some countries, notably in Germany and lately in the large abattoirs in the United States of America, is far from being perfect. The system is what may be termed a 'detective system'; that is to say, the butchers are warned by the Public Health Acts that they must not sell, or expose for sale, or prepare for sale, or deposit in any place for the purpose of sale, any animal, carcass, &c., which is diseased, or unsound, or unwholesome, or unfit for human food; and if anyone is detected doing so, he will, on conviction, be liable to fine or imprisonment. This is scarcely just to the butcher, since he is not a trained pathologist and able to recognize every kind of disease affecting the animals he slaughters. In some of our large towns, such as Glasgow, some attempt has been made to follow the method adopted in Germany and other countries, but still much has to be done before anything like a perfect system has been uniformly adopted. Scotland has set a good example in having abolished all private slaughter-houses in the large towns. No system of meat inspection can be efficient where large numbers of private slaughter-houses exist, the principal reasons being—(*a*) killing is performed at all hours; (*b*) the inspector cannot be present at the time every animal is slaughtered; (*c*) the dishonest butcher can, in the absence of the inspector, remove evidence of disease from the carcass and organs. Therefore the public have to depend a great deal on the honesty of the butchers for the purity of the meat supply, especially in rural districts. In addition to these defects, the Public Health Acts delegate the powers and duties relating to meat inspection to the medical officer of health and the sanitary inspector. The first-named official has so many duties to perform that he cannot find time to visit slaughter-houses at all hours, and it is doubtful if, unless having undergone special training, he has enough knowledge of the diseases of animals to make him the person most suited for the position: while the sanitary inspector has also multifarious duties to perform, in addition to which he lacks the scientific training to make a good meat inspector. In countries where meat inspection is systematically carried out, veterinary surgeons are appointed to all the responsible offices. They are assisted by a staff of specially trained inspectors (not necessarily veterinary surgeons), who inspect carcasses and organs, and detain anything doubtful until seen by the chief inspector. The late Professor Walley, of Dick Veterinary College, Edinburgh, was the first in this country to advocate the appointment of veterinary surgeons as chief meat inspectors; also that more attention should be given in the veterinary colleges to the subject of meat inspection. Gradually during the last fifteen years the teachers in the colleges and the public health authorities have adopted his recommendation, and most of the large towns now possess a veterinary surgeon as chief meat inspector. In small towns and villages, private slaughter-houses are almost unavoidable. To cope with this difficulty a veterinary surgeon should be appointed to a district, where he could, in addition to inspecting milch cows in the dairies, make surprise visits to the slaughter-houses, and instruct the local sanitary inspector to keep under observation any animal showing clinical symptoms of disease, or doubtful-looking animals; he could also instruct the inspector how to recognize the post-mortem appearances of the various diseases affecting food animals. The Local Government Board could appoint a veterinary surgeon on its staff, who would visit all the towns and report annually as to the efficiency of the meat inspection in the country. In all large towns a well-trained staff of inspectors should be appointed, and controlled by one or more veterinary surgeons. Attached to the abattoirs there should be a suitable dissecting room, and also a laboratory for microscopical work. Thus any contagious disease discovered could be at once reported to the Board of Agriculture. All carcasses after examination, if free from disease, should have stamps placed upon them showing the name of the abattoir, the date of inspection, and the inspector's initials. This is absolutely necessary, because no matter how carefully carcasses are inspected under the present system, there is no indication on a carcass that it has been inspected, nor can an inspector identify a carcass as one he has previously examined and passed. Thus a carcass may be passed by one inspector, taken into another district, and there seized by another inspector, whose opinions may differ from that of the first. All imported meat should bear stamps showing that it has been inspected at the time of slaughter, the date of inspection, the inspector's initials, and the country from

whence it came. The German system of *Freibanks* might be adopted in this country with benefit to the farmer, the butcher, and the public. It is said that the agriculturists in Germany have derived much benefit from the introduction of those freibanks, as the meat of animals which were not in perfect health can be legitimately utilized by being cooked to such a degree as to destroy all disease. Formerly this class of meat was either destroyed, or bought by a questionable class of butchers. In the inspection of meat the method adopted is as follows. The inspector in examining chilled meat carefully scrutinizes the serous membranes and incises the lymphatic glands. To examine frozen meat he may use a carpenter's brace and bit or an auger, noting carefully the condition of the meat which comes out with the 'bit' or 'auger'. A little heat applied to what is extracted will intensify the smell if decomposition exists in the meat. With regard to slaughter-house inspection, the scientific inspector, provided with his knowledge of anatomy, physiology, pathology, and bacteriology, examines all the organs of the dead animal, incising as he does so the lymphatic glands. Next he examines the carcass by carefully inspecting the serous membranes, incising the lymphatic glands to ascertain if the disease has gained entrance to the lymph stream, thus judging whether the disease is localized or generalized. He also examines the incised bones of the vertebræ and sternum. After completing his examination he decides whether the whole carcass and organs should be destroyed, or in part only.

Tuberculosis is one of the most important diseases the meat inspector has to deal with. The post-mortem appearances of this disease vary in form and extent. Tubercles may be present in almost any organ of the body, and also in the body itself. Those tubercles when present in the organs may vary in size from the borderland of microscopic visibility to that of a fist or much larger, some of the lymphatic glands being specially enlarged. Vegetations (so-called grapes) may be so plentiful on the serous membranes, especially in the thoracic cavity, as to form conglomerations so large that they could be dug out, and this is most commonly seen in old cows. On section the tubercles vary in appearance in different animals; in the pig the colour is light-grey, while in oxen it is yellowish. The consistency also varies, being either calcareous (gritty) or caseous, and in the opinion of experts those forms of tuberculosis are most dangerous in which softened tuberculous foci are found in the organs. The softening may be partly due to the presence of other organisms (staphylococci or streptococci). To the trained inspector there is not much difficulty in diagnosing tuberculosis, as in a case of doubt he can use the microscope; but it is possible for the untrained officer to mistake some post-mortem appearances (pyæmia, actinomycosis, calcified cysts, &c.) for the disease.

The recommendations of the Royal Commission on Tuberculosis issued by the Local Government Board as a guide to meat inspectors are as follows:—

The carcass, if otherwise healthy, shall not be condemned, but every part of it containing tuberculous lesions shall be seized—

(*a*) When the lesions are confined to the lungs and the thoracic lymphatic glands.

(*b*) When the lesions are confined to the liver.

(*c*) When the lesions are confined to the pharyngeal lymphatic glands.

(*d*) When the lesions are confined to any combination of the foregoing, but are collectively small in extent.

The entire carcass and all the organs may be seized—

(*a*) When there is miliary tuberculosis of both lungs.

(*b*) When tuberculous lesions are present on the pleura and peritoneum.

(*c*) When tuberculous lesions are present in the muscular system or in the lymphatic glands, embedded in or between the muscles.

(*d*) When tuberculous lesions exist in any part of an emaciated carcass. In view of the greater tendency to generalization of tuberculosis in the pig, we consider that the presence of tubercular deposit in any degree should involve seizure of the whole carcass and of the organs. In respect of foreign dead meat, seizure shall ensue in every case where the pleuræ have been 'stripped'. In the opinion of many experts, the recommendations with regard to carcasses of pigs affected with tuberculosis are too severe. They think that where *only* the lymphatic glands of the head are affected, the head could be cut off, and the carcass, if free from disease, passed.

With regard to other diseases no regulations are issued, so that an inspector must use his own judgment. The Local Government Board advise sanitary inspectors to consult the medical officers of health when in doubt as to the disposal of a carcass. The undermentioned diseases are those most commonly observed while inspecting meat:—

In the head—Actinomycosis, tuberculosis, abscesses.

In the tongue—Actinomycosis, tuberculosis, abscesses, parasitic disease (cysticerci in the pig).

In the lungs—Parasitic diseases, pneumonia (various kinds), tuberculosis, septicæmia-hæmorrhagica, pleurisy, and emphysema.

In the heart—Pericarditis (tubercular, septic, and idiopathic), endocarditis.

In the liver—Hepatitis, fatty degeneration, fatty infiltration, cirrhosis, bacillary necrosis, jaundice, abscesses, parasitic diseases, and tuberculosis.

In the stomach—Tuberculosis, abscesses (due to foreign bodies in the reticulum), gastritis, &c.

In the spleen—Tuberculosis, tumours, enlargement due to anthrax or red water.

In the mesentery—Evidence of tuberculosis and Johne's disease in the lymphatic glands.

In the intestines—Evidence of Johne's disease, swine fever, enteritis, and parasitic disease (*Œsophagastoma columbianum*).

In the kidneys—Tuberculosis, nephritis (various forms), and parasitic disease.

In the bladder—Cystitis, evidence of red water, &c. [T. D. Y.]

Mechi, John Joseph, the most notable of the 'apron-string farmers' of the latter half of the 19th century, and a strong and eloquent advocate of advanced agriculture. Mr. Mechi, the son of a native of Bologna who settled in London some time before 1800, was born at Blackheath, near London, in 1802. By 1841 he had made a considerable fortune in business, and part of it he invested in four farms. Failing to induce his tenant at Tiptree Hall, Essex, to pay interest upon the draining which he offered to carry out in the water-logged soil, he paid the man to go out, and himself became the occupier. He at once began to improve the farm by draining, chalking, and manuring it; and when steam cultivation became feasible, he employed it, and strongly advocated its general use. Mr. Mechi made some costly mistakes, and committed himself to the advocacy of some practices which did not stand the test of experience. He was a prolific writer of books and articles in the agricultural papers, as well as an eloquent speaker. His name soon became a household word, not only in Great Britain, but also in foreign countries, and his books had a large circulation. He was most persevering in urging landlords to drain their estates and to improve farm buildings, and tenants to pursue high farming. Altogether, in spite of his errors, he did a great amount of good to agriculture. In 1856 Mr. Mechi was made Sheriff of London and Middlesex, and in 1858 an Alderman of the City. In 1860 he founded the Agricultural Benevolent Institution, perhaps the finest action of his useful life. He was Chairman of the London Farmers' Club in 1877. He died in 1881, in the seventy-ninth year of his age. [W. E. B.]

Medicago is the botanical name for the Medick genus of leguminous plants, distinguished when in fruit by the curved or spiral pods. The leaf-blade is composed of three leaflets (trifoliate), with a toothed margin, and a notched apex from which a short prong (mucro) springs. The petals do not persist as in clovers,

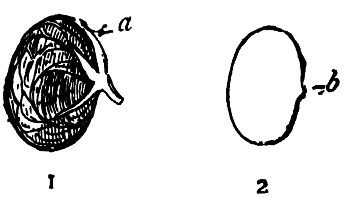


Fig. 1.—Yellow Trefoil

1, Black indehiscent pod (× 7). 2, Seed (× 7). *a*, Persistent calyx. *b*, Projecting point.

but wither and fall off, leaving the fruit bare (fig. 1).

Two species are useful in agriculture: (1) Black Medick, Nonsuch, or Yellow Trefoil (*Medicago lupulina*). (2) Purple Medick, Lucerne, or Alfalfa (*Medicago sativa*).

Black Medick, Yellow Trefoil, or simply Trefoil, is an annual or biennial of light calcareous land, with a small spherical head of yellow flowers. When in fruit, the head lengthens, and now shows the small black kidney-shaped pods with ribbed surface, each pod containing one yellow seed. These seeds are cheap, and sometimes used for purposes of adulteration. They are glossy, and easily recognized by their greenish-yellow colour, elliptical outline, and the sharp projecting point of the radicle within (fig. 1). The plant has a taproot which descends to a depth of 1 ft., and, from the crown of this root, ground branches extend for a distance horizontally and then bend up (procumbent growth).

This trefoil is specially valuable for forming herbage on poor, light, calcareous land incap-

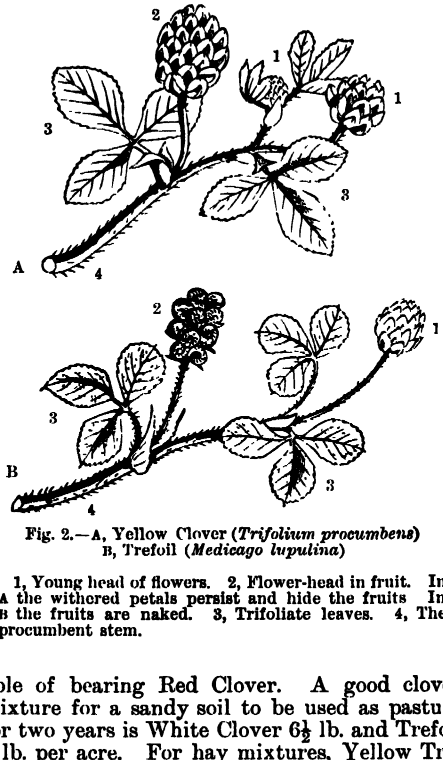


Fig. 2.—A, Yellow Clover (*Trifolium procumbens*) B, Trefoil (*Medicago lupulina*)

1, Young head of flowers. 2, Flower-head in fruit. In A the withered petals persist and hide the fruits In B the fruits are naked. 3, Trifoliate leaves. 4, The procumbent stem.

able of bearing Red Clover. A good clover mixture for a sandy soil to be used as pasture for two years is White Clover 6½ lb. and Trefoil 9 lb. per acre. For hay mixtures, Yellow Trefoil is unsuitable because of the procumbent habit of growth above described. This plant is often erroneously named 'Yellow Clover'; attention to the accompanying figures will prevent this confusion.

Purple Medick, Lucerne, or Alfalfa is a deep-rooted perennial distinguished by erect habit of growth, trifoliate leaves, purple flowers, and spirally coiled legumes containing many seeds. Under ordinary circumstances the roots of leguminous plants penetrate to the following depths: White Clover, 6 in.; Yellow Trefoil, 12 in.; Red Clover, 24 in.; Lucerne, 48 in. In agriculture, Lucerne is important because it is perennial, early, and very productive on deep, light, calcareous soils so dry that Red Clover would be killed out. Although this plant thrives best in warm countries, it is not sensitive to cold, and can be grown even in the south of Scotland. Shading is so injurious that Lucerne

is killed out if sown under a cereal; indeed, any uncleanness of the land acts very injuriously. It should never be grown in mixtures, but sown pure at the rate of 20 lb. of seed per acre, in drills 6 or 8 in. apart to allow the use of horse or hand hoes. To favour the growth of the young Lucerne plants, the land may be inoculated with special germs sold in small tubes for the purpose. Lucerne yields at least two cuts of green food in the year, of a quality highly relished by horses and cattle. See LUCERNE. [A. N. M'A.]

Medicines, Administration of.—Nauseous medicines must be given by guile or force. Some medicaments are willingly taken by animals in their food, and these of a class so bitter to the human palate as to excite surprise. It may be explained by the bitter and often acrid taste of many pasture plants, particularly the Ranunculaceæ, to which herbivora are accustomed. Men who are required to administer medicines to animals naturally prefer the powder to all other forms of medication. Mixed with the ordinary ration, or with the addition of spices or prepared 'foods' containing such things as salt, fenugreek, aniseeds, caraways, cumin, and the like, most animals can be induced to take drugs. So powerful a chemical as pure carbolic acid is frequently given in the food, and only a small proportion of cattle refuse it. Linseed and castor oils, cod-liver oil, and medicinal doses of croton oil mixed with linseed, will generally be taken. The horse is the most fastidious of the domesticated animals, and for him the ball or bolus is more generally prescribed. Active principles or concentrated drugs may be made up to a convenient size by the addition of some innocuous medium such as linseed meal; and treacle, honey, syrup, or other viscid fluid may be used as an excipient. A cylindrical bolus weighing 1 oz. to 12 dr., and not less than 2 in. long, is convenient for administration. Balls as they are called are also given to cattle, a practice not followed by the early veterinarians, who expected them to be returned by ruminants. A horse to be balled should have a hemp halter on, with the tag hanging loose. The operator should stand in front of him, but slightly to the left side, holding the ball between his thumb and two first fingers of the right hand. With the left he should seize the tongue, turn the point up in contact with the tush or thereabouts, and deftly pass the ball over the dorsum or thick part of the tongue, withdrawing his hand promptly and allowing the animal to close its mouth, immediately afterwards winding the free tag round the mouth, and there maintaining it until he has seen the bolus pass down the channel of the neck on the horse's left side. Drugs requiring free dilution, or solution in water, or needing to be given in large quantities, are horned or bottled down the throat while the head is held up in part by force and in part by persuasion. Horses should be drenched slowly, watching each 'go-down'; cattle, with larger gullets, are more easily made to take a draught, if once secured by finger and thumb in the nostrils, but this way of holding should not be resorted to if the animal is docile. A straight neck is desirable, as choking more frequently happens when the head is turned round. Electuaries (see LARYNGITIS) are placed upon the tongue high up. Enemata or clysters are used to convey medicines. Suppositories and pessaries present no difficulties unless the patient is vicious, and the same may be said of hypodermic and intertracheal injections. [H. L.]

Medicines, Doses of.—The therapeutic value of a drug does not depend upon an exact estimate of the dose required, yet many persons are deterred from prescribing because they do not realize this, and the greater importance of correct diagnosis and good nursing. Within certain limits such as are indicated in the posological table that follows, the amateur is not likely to commit any serious error; but if any doubt exists in his mind he should 'err on the safe side'. It is possible to make a general classification of patients according to the species, age, weight, &c., with those well-known and easily obtained medicines to which we have confined ourselves in a work intended for 'all sorts and conditions of men', and in situations where the latest pharmaceutical products may not be had. The list is alphabetically arranged, and the medicines are named in the manner customers ask for them at the druggist's shop, thus sulphate of iron, not iron sulphate as in catalogues. A 'dose' here means the usual amount prescribed for an adult, and it is left to the prescriber's judgment to increase or diminish it for an extra-sized or smaller animal.

Horses, three years old and upwards	The full dose.
Eighteen months old	Half the dose.
Nine months old	One-fourth.
Four or five months old	One-eighth.

For cows, about one-third more than for horses, as the contents of the voluminous stomach absorb unprofitably some 30 per cent or more of the medicine. It is for the same reason that doses prescribed for sheep do not bear the same proportion to carcass weight as those given to pigs and dogs with single stomachs. The veterinarian will make some difference when prescribing for a big Shorthorn bull and a little Jersey or Kerry cow, as he also will in dosing a large Yorkshire white sow, a St. Bernard dog, or a toy terrier. 'Dose' in our table should be understood to mean for animals of a general average size, according to species or breed. The usual abbreviations are adopted to save space: thus oz. for ounce, dr. for dram or drachm, gr. for grain, min. for minim or drop. Spirituous preparations, as ethers and tinctures, should be freely diluted, and soluble salts, as Epsom salts, the bicarbonates of potash and soda, hyposulphites, &c., should be dissolved in a plenitude of water; it being generally conceded that, with the former class, accidents in administration are less likely to occur, and that in the latter a better result is obtained.

In the absence of weights and measures, teaspoons of the smaller kind may be used for drams of liquids, and multiplied by 8 to make an ounce. Tablespoons should hold half an ounce, and wineglasses two ounces, ten of which

Medicines.	Horse.	Sheep	Pig.	Dog.
Aloes	2 — 8 dr.	1 — 6 dr.	2 — 4 dr.	20 —100 gr.
Alum	2 — 4 dr.	½— 1½ dr.	20 —60 gr.	10 —20 gr.
Aniseed	½— 1½ oz.	1 — 2 dr.	½— 2 dr.	10 —30 gr.
Antimony, Black	1 — 3 dr.	10 —30 gr.	6 —20 gr.	2 —10 gr.
Antimony, Tartarized, for worms (Emetic Tartar)	1 — 3 dr.	——	3 —12 gr.	2 — 6 gr.
Antimony, Tartarized, as Febrifuge...	½— 1 dr.	2 — 6 gr.	1 — 4 gr.	½— 2 gr.
Areca Nut	½— 2 oz.	1 — 3 dr.	20 —100 gr.	20 —120 gr.
Aromatic Spirit (Sal Volatile) ...	½— 2 oz.	1 — 2 dr.	½— 2 dr.	10 —60 min.
Asafœtida	2 — 6 dr.	1 — 2 dr.	15 —60 gr.	5 —20 gr.
Belladonna Extract	½— 2 dr.	5 —15 gr.	3 —10 gr.	1 — 5 gr.
Bicarbonate of Potash	½— 1½ oz.	1 — 3 dr.	½— 3 dr.	10 —40 gr.
Bicarbonate of Soda	2 — 6 dr.	1 — 2 dr.	½— 2 dr.	10 —40 gr.
Boracic Acid	1 — 4 dr.	10 —40 gr.	10 —30 gr.	5 —15 gr.
Bromide of Ammonium	2 — 8 dr.	20 —60 gr.	10 —30 gr.	5 —15 gr.
Bromide of Potassium	2 — 8 dr.	½— 2 dr.	15 —50 gr.	5 —20 gr.
Calomel	15 —60 gr.	4 —10 gr.	2 — 6 gr.	½— 3 gr.
Calumba	2 — 6 dr.	½— 2 dr.	15 —60 gr.	5 —15 gr.
Camphor	1 — 4 dr.	10 —30 gr.	5 —20 gr.	2 —10 gr.
Cantharides	5 —10 gr.	1 — 5 gr.	½— 3 gr.	¼— 1 gr.
Caraways	½— 2 oz.	1 — 2 dr.	10 —60 gr.	5 —20 gr.
Carbolic Acid	½— 2 dr.	10 —20 min.	5 —15 min.	1 — 5 min.
Carbonate of Ammonia	2 — 6 dr.	15 —40 gr.	5 —20 gr.	2 —10 gr.
Carbonate of Iron	1 — 4 dr.	15 —40 gr.	10 —20 gr.	2 —10 gr.
Castor Oil	10 —30 oz.	2 — 8 oz.	1 — 4 oz.	1 —12 dr.
Cayenne Pepper	½— 3 dr.	10 —40 gr.	5 —20 gr.	1 — 5 gr.
Chalk	½— 2 oz.	1 — 4 dr.	½— 3 dr.	5 —20 gr.
Charcoal...	½— 2 oz.	1 — 3 dr.	1 — 4 dr.	10 —40 gr.
Chinosol	20 —80 gr.	10 —30 gr.	5 —20 gr.	2 —10 gr.
Chloral Hydrate	½— 1½ oz.	½— 2 dr.	15 —60 gr.	5 —20 gr.
Chlorate of Potash	1 — 3 dr.	½— 1½ dr.	10 —40 gr.	5 —15 gr.
Chloride of Ammonium	2 — 6 dr.	1 — 3 dr.	15 —40 gr.	5 —20 gr.
Chloride of Lime	2 — 6 dr.	15 —60 gr.	10 —40 gr.	5 —15 gr.
Chloride of Sodium (Common Salt)	1 — 2 oz. Cows, 8 18 oz. red water, &c.	1 — 4 dr.	1 — 3 dr. as emetic	——
Chlorodyne	2 —12 dr.	1 — 4 dr.	10 —40 min.	5 – 20 min.
Chloroform	1 — 2 dr.	10 —30 min.	10 —50 min.	5 —20 min.
Cocaine	2 — 8 gr.	1 — 3 gr.	½— 2 gr.	⅛— 1 gr.
Cod-liver Oil	2 — 6 oz.	2 — 8 dr.	1 — 4 dr.	10 – 60 min.
Coriander	4 —12 dr.	1 — 3 dr.	½— 2 dr.	5 —20 gr.
Cream of Tartar	1 — 3 oz.	1 — 4 dr.	½— 3 dr.	3 —15 gr.
Croton Oil	5 —10 min.	1 — 4 min.	3 —10 min.	½-- 2 min.
Easton's Syrup	½— 2 oz.	1 — 3 dr.	½— 2 dr.	5 —40 min.
Epsom Salts	1 — 2 oz. as alterative, ½— 1½ oz. to purge cows	1 — 2 dr. as alterative, 1 — 4 oz. as purgative	½— 3 oz.	1 — 4 dr.
Ergot	½— 1 oz.	½— 1 dr.	20 —60 gr.	5 —20 gr.
Ether, Sulphuric	½— 1½ oz.	1 — 3 dr.	½— 2 dr.	20 —60 min.
Eucalyptus Oil	20 —60 min.	5 —20 min.	5 —20 min.	3 —10 min.
Gentian Root	2 — 8 dr.	1 — 4 dr.	½— 2 dr.	5 —20 gr.
Ginger	½— 2 oz.	1 — 4 dr.	½— 2 dr.	5 —20 gr.
Glauber Salts	1 — 3 oz. as alterative, ½— 1 lb. as purgative	1 — 3 dr. as alterative, 1 – 4 oz. as purgative	1 — 4 dr. as alterative	5 —20 gr.
Glycerine	2 — 6 oz.	½— 3 oz.	½— 2 oz.	1 — 4 dr.
Hydrochloric Acid (dilute), B.P. ...	1 — 4 dr.	30 —60 min.	20 —40 min.	5 —15 min.
Hyposulphite of Soda	1 — 4 dr.	½— 2 dr.	20 —80 gr.	5 —20 gr.
Iodide of Potassium	1 — 6 dr.	10 —40 gr.	10 --100 gr.	3 — 6 gr.
Iodine	10 --60 gr.	2 — 6 gr.	1 — 4 gr.	½— 2 gr.
Iodoform	1 — 2 dr.	10 —30 gr.	10 —20 gr.	3 — 8 gr.
Jalap	——	——	1 — 4 dr.	½— 2 dr.
Juniper Berries	½— 1½ oz.	1 — 4 dr.	½— 1½ dr.	——
Laudanum (Tincture of Opium) ...	1 — 3 oz.	1 — 4 dr.	½— 2 dr.	10 —30 min.
Linseed Oil	½— 1½ pt.	2 —10 oz.	2 — 8 oz.	——
Male Fern (extract liquid) ...	½— 1½ oz.	1 — 3 dr.	½— 2 dr.	15 —30 min.
Morphine	5 —10 gr.	1 — 3 gr.	½— 1½ gr.	⅛— ¼ gr.
Mustard	½— 2 oz.	1 — 2 dr.	½— 1½ dr.	2 — 5 dr. as emetic
Nitrate of Potash (Nitre, Saltpetre)	1 — 8 dr.	10 —40 gr.	10 —30 gr.	5 —15 gr.
Nitric Acid (dilute)	1 — 4 dr.	20 —60 min.	15 —40 min.	5 —15 min.
Nux Vomica	20 —80 gr.	4 —16 gr.	2 —10 gr.	¼— 1½ gr.
Oak Bark	2 — 6 dr.	1 — 2 dr.	½— 2 dr.	5 —15 gr.
Oil of Juniper	30 —90 min.	10 —30 min.	7 —20 min.	3 —10 min.
Opium, Powdered	1 — 4 dr.	10 —30 gr.	5 —20 gr.	1 — 5 gr.

Medicines.	Horse.	Sheep.	Pig	Dog.
Pepper (Black or White)	1 — 4 dr.	10 —30 gr.	10 —25 gr.	——
Quassia	3 — 8 dr.	1 — 3 dr.	1 — 3 dr.	10 —30 gr.
Quinine	20 —100 gr.	5 —20 gr.	4 —16 gr.	1 — 6 gr.
Resin	4 — 8 dr.	$\frac{1}{2}$— $1\frac{1}{2}$ dr.	$\frac{1}{2}$— 1 dr.	5 —20 gr.
Rhubarb	4 — 8 dr.	$\frac{1}{2}$— 2 dr.	10 —40 gr.	5 —20 gr.
Santonin	15 —60 gr.	5 —20 gr.	3 —15 gr.	1 — 7 gr.
Solution of Ammonium Acetate ...	2 — 6 oz.	$\frac{1}{2}$— 2 oz.	2 — 8 dr.	$\frac{1}{2}$— 2 dr.
Spirit of Nitre	$\frac{1}{2}$— 3 oz.	2 — 4 dr.	1 — 4 dr.	10 —50 min.
Subnitrate of Bismuth	1 — 4 dr.	20 —60 gr.	8 —25 gr.	2 – 10 gr.
Sugar of Lead (Acetate)	$\frac{1}{2}$— $1\frac{1}{2}$ dr.	10 —20 gr.	4 —16 gr.	$\frac{1}{2}$- 2 gr.
Sulphate of Copper	$\frac{1}{2}$— 2 dr.	15 —30 gr.	3 —12 gr.	$\frac{1}{2}$— 3 gr.
Sulphate of Iron	1 — 3 dr.	20 —60 gr.	10 —30 gr.	2 — 6 gr.
Sulphate of Zinc	$\frac{1}{2}$— 2 dr.	6 —15 gr.	3 —10 gr.	$\frac{1}{2}$— 2 gr. 15 —25 gr. as emetic
Sulphur Flowers	$\frac{1}{2}$— 2 oz.	1 — 4 dr.	$\frac{1}{2}$ dr.—2 oz.	5 —20 gr.
Sulphuric Acid (dilute)	1 — 4 dr.	10 —30 min.	5 —20 min.	3 —10 min.
Syrup of Buckthorn	——	——	——	$\frac{1}{2}$— 2 oz.
Tannic Acid	$\frac{1}{2}$— $1\frac{1}{2}$ dr.	10 —25 gr.	5 —20 gr.	3 —10 gr.
Tincture of Aconite B.P.	15 —40 min.	3 —10 min.	2 — 8 min.	1 — 5 min.
Tincture of Arnica	$\frac{1}{2}$— $1\frac{1}{2}$ oz.	40 —80 min.	20 —50 min.	——
Tincture of Benzoin Comp. (Friar's Balsam)	$\frac{1}{2}$— 2 oz.	$\frac{1}{2}$— 2 dr.	20 —80 min.	5 —20 min.
Tincture of Catechu	$\frac{1}{2}$— 2 oz.	1 — 4 dr.	$\frac{1}{2}$— 3 dr.	10 – 50 min.
Tincture of Ginger	$\frac{1}{2}$— 2 oz.	$\frac{1}{2}$— 2 dr.	20 —80 min.	5 —30 min.
Tincture of Iron	$\frac{1}{2}$— 4 dr.	10 —30 min.	5 —20 min.	2 —10 min.
Turpentine Spirit	$\frac{1}{2}$— 2 oz.	1 — 4 dr.	20 —40 min.	5 —20 min.
Venice Turpentine	2 — 4 dr.	10 —30 gr.	10 —25 gr.	2 —10 gr.

should make a pint. An ordinary wine or spirit bottle holds about a pint and a quarter, or five gills. [H. L.]

Medick, the popular designation of a genus of plants belonging to the nat. ord. Leguminosæ. See art. MEDICAGO.

Mediterranean Flour Moth, one of the worst scourges of the flour mill. See EPHESTIA.

Medlar, a small deciduous tree (*Mespilus* (*Pyrus*) *germanica*, nat. ord. Rosaceæ), a native of Europe (including Britain) and Asia. The acid fruits are esteemed by comparatively few, and the saying that they are no good until rotten is correct, in so far as they cannot be eaten until they turn brown and commence to decay—bletting being the technical term. They should be gathered at the end of October, selecting a dry day, and placed in the fruit store. It is recommended that the stalks be dipped in salt, as tending to keep off a fungus which is very destructive to this fruit. They will be fit for use (they are generally eaten raw, but may be made into a preserve) in about a fortnight, and should keep until the New Year. The principal varieties are the Dutch, Royal, Stoneless, and Nottingham, the last-named being preferred by reason of its upright habit and the superior quality of the fruits. The Medlar is usually grafted, the best mode being standard high upon the pear stock. Seeds take two years to germinate. This tree is not particular as to soil, and requires very little pruning. [W. W.]

Megachile centuncularis (the Rose Leaf-cutter).—Roses are frequently noticed with their foliage severely damaged by the so-called leaf-cutting bees. These insects bite out large semicircular pieces of the leaves to make their nests, and here and there are seen to cut out circular areas. The above-named is the rose pest. It makes its burrows for nesting in decaying wood and in brick walls, and even in the ground. Besides the leaves of the rose, this species also uses the leaves of the annual and perennial Mercuries (*Mercurialis annua* and *M. perennis*). The leaf-cutting bee of the rose varies from a little under to a little over $\frac{1}{2}$ in. in length. It is a brownish bee with hairs on the abdomen and thorax of a sooty-brown hue, brighter at the sides. The segments of the abdomen are deeply impressed across the base, the first and second have pale hairs, the rest black at the base, paler apically at the sides, and there is an orange hue ventrally. The head is large with strong jaws.

Treatment.—All we can do with the attack on roses is to try and locate the nests and destroy them, and frequent sprayings with soft soap and quassia have been found to keep the bees off to some extent. [F. V. T.]

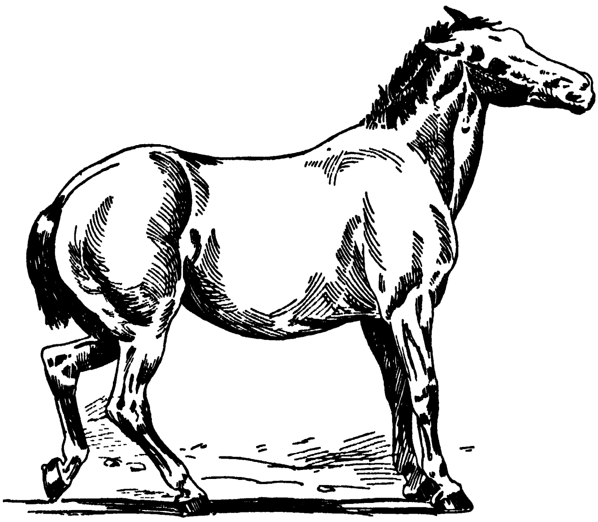
Megastigmus spermotrophus (the Douglas Fir Seed Pest).—This pest attacks the seed of one of our most important trees for ornamental and timber purposes—the Douglas Fir, which was introduced in the last century. *Megastigmus* belongs to the hymenopterous family Chalcididæ, the majority of which are parasitic on other insects. It is a small loam-yellow Chalcid, with red-brown on the head and red-brown on the thorax; abdomen red-brown on upper side, with a dark spot at the base of the first segment; pale beneath and at the apex. The sheath of the ovipositor black. The male is more of an orange-yellow, with a black patch in front of the thorax and another behind; base of wings and metanotum black; abdomen compressed, brownish-red, with a black longitudinal patch at its base. The female is $\frac{1}{8}$ to $\frac{1}{7}$ in. long, and the male $\frac{1}{9}$ to $\frac{1}{8}$ in. The larva is whitish and colourless and legless;

the segments well marked. The life-history recorded by MacDougall is that in Scotland it occurs from May onwards. The females lay their eggs in the young Douglas Fir cones. Each infested seed contains one larva, showing no external marks of its presence. Pupation takes place in the seed. No cocoon is formed. The generation appears to be an annual one. Males and females occur in May and June in Scotland.

Protection and Remedy.—Seed should be fumigated with bisulphide of carbon at the rate of about 1 oz. to every 100 lb. of seed in the usual way. Cones that are stored should also be fumigated. Seed should also be screened, and the light seed refuse burnt. Little can be done to large trees and even in nurseries. [F. V. T.]

Megninia asternalis, a mite which occurs on poultry but does no appreciable damage. [F. V. T.]

Megrims. — Megrims or vertigo in the horse is disturbed cerebral function, varying



Megrims or Vertigo

in degree, intensity, and duration, and assigned to various causes, as organic disease of the brain, disordered liver, indigestion, or exposure to the direct rays of the sun in sultry weather. Besides these probable causes, there would seem to be some other as yet undiscovered, as postmortem examination of confirmed subjects, which have suffered in all weathers, has shown no lesions. The disease is usually of gradual development, and often with considerable intervals between the attacks, and horses liable to them frequently change hands. The substitution of a piped collar, which makes the descent of the blood in the jugular veins easier, has been found to answer in some cases; keeping the bowels regular and somewhat pultaceous is more or less of a safeguard, and attention to digestive disorders. When associated with congested liver (see LIVER, DISEASES OF), a dose of calomel and aloes is often found to afford immunity from an attack for some time. The ordinary seizure, in which the animal stops and shakes his head, may possibly go no further, if he is allowed to stand for a few minutes, but this may be followed by his leaning to one side and falling down in a state of unconsciousness. Bleeding from the palate appears to give almost immediate relief. The subjects of megrims should not be worked soon after feeding. [H. L.]

Melampyrum, commonly called Cow-wheat, is the name for a genus of bald, erect, annual weeds with narrow opposite leaves belonging to the dicotyledon class and to the nat. ord. Scrophulariaceæ. The corolla of the flower is two-lipped, with the upper lip compressed laterally; the colour is yellow, in some species variegated with purple. Unlike its ally Yellow Rattle, Cow-wheat has the calyx fitting tight on the corolla (tubular), not loose and baggy; the seeds also are shaped like grains of wheat, not flat bodies with a winged margin. The Cow-wheats occur sometimes in woods and damp meadows, and sometimes as weeds in the corn. The mode of life is peculiar. Each species lives: (1) as a green plant, (2) as a partial root parasite, and (3) as a saprophyte preying on the dead organic matter in the soil. In hay, the plants become quite black, like the other semi-parasites of the order Scrophulariaceæ, namely Lousewort (Pedicularis), Yellow Rattle (Rhinanthus), Eyebright (Euphrasia), and Bartsia. Hay containing such weeds is poisonous, and may act injuriously on animals that have eaten it. [A. N. M'A.]

Melanoxanthus salicis (the Coloured Willow Aphis), a large and very conspicuous aphis found on osiers and willows, often occurring in dense masses and doing considerable damage to young rods. The apterous female is nearly $\frac{1}{8}$ in. long, dull sooty or greyish black, with a grey median stripe; two broad grey patches on each side of the first abdominal segment, smaller patches on each of the other rings. Antennæ orange-red; cornicles bright-orange and very short. Legs orange, with dark tibial joints and tarsi. The larvæ are black, and prettily streaked with grey. The winged viviparous female is very large, up to $\frac{1}{4}$ in. long, with wing expanse of over $\frac{1}{2}$ in.; colour greyish-black; abdomen with two grey patches; antennæ black and orange, cornicles orange, legs black and yellow; wings with black veins. These winged forms occur in June and July, the wingless ones may be noticed in May. They not only stunt the growth of the rods but they stain them, and they frequently break where a colony has been present. Now and then they are preyed upon by a species of Aphidius.

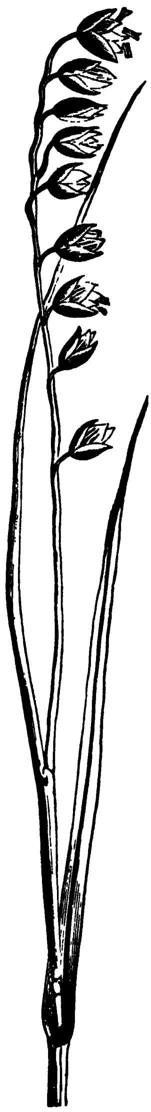
The only treatment is crushing the colonies with a gloved hand. [F. V. T.]

Melasoma populi (Red Poplar Leaf-beetle).—This beetle is rather less than $\frac{1}{2}$ in. long, with blackish-blue head and thorax, and bright brick-red elytra, their extreme apex being

black in some specimens; the thorax is much narrower than the elytra; the antennæ short and thickened towards the ends. The beetle appears in May and June, and lays her yellowish-white ova in clusters of about a dozen on the leaves of young poplars. One female may lay as many as 150 eggs. The larvæ emerge in June and July and feed on the leaves. They are six-legged, dirty-white with many dark spots, and two white lateral projections on the second and third segments. When disturbed they emit a milky white fluid with an odour of bitter almonds. They are mature by August, and pupate on the foliage, the pupæ hanging attached by their ends. In August the beetles emerge, and hibernate over the winter. It is locally common over Britain. Both beetles and larvæ damage the young poplars and aspen shoots, and are sometimes found on osiers and willows. The larvæ skeletonize the leaves, the parenchyma being eaten and the veins left intact. The beetles eat holes in the leaves. The only protection is beating the beetles off into cloths and destroying them, or spraying with arsenate of lead where nursery stock or special trees in parks and gardens are concerned.

Another species, *M. tremulæ* (the Aspen Red Beetle), can be told by having no black tips to the elytra. It is equally harmful, and has a very similar life-cycle. [F. V. T.]

Meld Weed.—This weed, also known as Fat-hen, Goosefoot, and Lamb's-quarter, is described in the art. GOOSEFOOT.



Melic Grass

Melic Grass (*Melica nutans*) is a wild perennial of damp woods and hedgerows, which has occasionally been recommended for agricultural use, but it turns out to have no importance. This grass is readily identified by its characteristic ear—a simple, loose, one-sided drooping raceme of two-flowered spikelets, as shown in the accompanying figure. Another species of Melic (*Melica uniflora*) grows in woods. This species is readily distinguished by the awl-shaped process at the apex of the leaf-blade, on the face of the straw opposite the leaf-blade. See fig. in art. GRASSES. [A. N. M'A.]

Melilot is the common name for a genus of annual or biennial leguminous herbs (Melilotus), distinguished by the leaf-blade, composed of three stalked and toothed leaflets (trifoliate), by the axillary racemes of white, yellow, or blue flowers, and, when in fruit, by the straight, short, one- to four-seeded pods, which are exposed when the withered corolla falls away. All the species have a characteristic fragrant odour, specially marked when the herbage is dry: this odour is due to the presence of cumarin, the same substance that gives the scent to hay containing Sweet Vernal Grass. The species are of little importance as forage, since stock do not readily eat the produce on account of the presence of the cumarin.

WHITE MELILOT (*Melilotus alba*), the white-flowered species, has been recommended as a forage crop for poor sandy soils, under the names of Siberian Melilot, Bokhara clover, Cabul clover, &c. Although very productive, the produce is

Common Melilot (*Melilotus officinalis*)

useless, for stock reject it. Nevertheless, this species may be useful for ploughing in as a green manure.

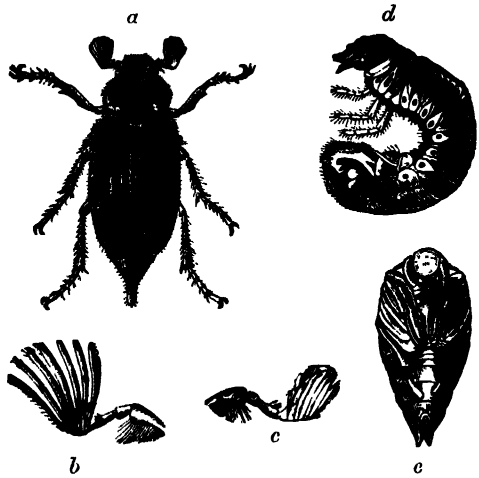
YELLOW OR COMMON MELILOT (*Melilotus officinalis*), the yellow-flowered species, is an annual sometimes introduced with corn. It is less productive than White Melilot, and worthless as a forage crop.

BLUE MELILOT OR OLD SOW (*Melilotus azureus*) is an annual Swiss plant sometimes grown in gardens. The dried flowers, powdered and worked up into a paste with curd, are used in Switzerland to communicate odour and flavour to Schapziger cheese. [A. N. M'A.]

Melolontha vulgaris (the Cockchafer).—This beetle (which belongs to the family Melolonthidæ—see next article) is a little more than 1 in. in length. The thorax is black to dark reddish-brown; the wing cases reddish-brown, with five smooth longitudinal ridges on each; the depressions between the ridges have scanty, small white scales, and the rest of the body is downy; the abdomen overlaps the elytra, and in the female terminates in a curved, thick,

blunt ovipositor; at the sides of the abdomen, which is brownish-black, are white triangular patches. Legs reddish-brown. The short antennæ have the club, which expands fan-like, with six leaves in the female, seven in the male. The adult beetles feed upon the leaves of oak, beech, maple, elm, chestnut, larch, apple, plum, cherry, nut, raspberries, and strawberries. In some cases they even eat the shoots of larch and young oaks. The beetles now and then appear in such numbers that they cause complete defoliation. The time of appearance is in May and June, when they may be found hanging in a torpid state on the leaves of trees, coming out at dusk and at once commencing to feed.

The females deposit their eggs in the soil at a depth varying from 2 to 8 in., depending on the



The Cockchafer (*Melolontha vulgaris*)[1]

a, Male beetle *b*, Antenna of male with seven lamellæ. *c*, Antenna of female with six lamellæ. *d*, Grub. *e*, Pupa (ventral surface).

nature of the soil. They are roundish in shape and yellowish-white in colour, and placed in heaps of from fifty to eighty. They are about the size of a hemp seed. The larvæ take three years to develop. When mature they reach 1½ in. in length. This Chafer grub is dirty-white, thick and fleshy, the tail end of the body swollen into a kind of bladder-like sac; the segments well marked; the head large, deep-brown, and horny, the mouth armed with strong biting jaws or mandibles, which in this species have a granulated area where the light and dark parts of the jaws unite. They lie in the soil in a curved position and move but slowly. A dense root mass seems to attract them. The small and large roots of fruit bushes, young fruit and forest trees are attacked, the smaller rootlets being eaten, and the larger have the outer epidermis gnawed off. In this way great damage is done by them. They feed not only near the surface, but may go down to a depth of 1 to 2 ft. when nearing maturity at the end of their third year.

[1] Reproduced (by permission) from Schlich's *Manual of Forestry*, Vol. IV.

There is then formed an earthen cell by them, in which pupation takes place, and in the following May or June the adults emerge from the ground. It appears that they hatch out from the pale-brown pupa some time before they make their exit. This beetle usually occurs in large numbers in certain years—'Chafer years'.

Natural Enemies.—The larvæ are preyed upon by rooks, starlings, plovers, and gulls. The first and last named can be seen following the plough and picking them up, and also probing through the grass in meadows, doing inestimable good.

Prevention and Treatment.—The larvæ being almost impossible to destroy in field cultivation, it is well to take steps to have the beetles collected when they appear in large numbers, by shaking them off the isolated trees they shelter amongst in daytime on to sacks. In this way, on a Mayenne estate in France, 2000 lb. were collected in one summer. Pigs will readily devour them, or they may be burnt. It is said they only go into woods in bad weather—so this makes the process easier. In gardens and vine borders, and even hop yards, the white grubs may be trapped by placing turves upside down, the grass side just under the soil. The larvæ congregate there, and can be easily collected and killed. Kainit has been found useful where the larvæ are working in the soil. On grassland a heavy dressing of gas lime has frequently been used, and is found to kill grass and grubs, although a seemingly drastic remedy; but the resulting grass crop in the following year becomes excellent, even too strong. In the case of corn and pulse crops, frequent horse and hand hoeing does some good.

Attempts have been made in France and Germany to destroy the larvæ with fungoid parasites, such as *Botrytis tenella* and *Isaria densa*, but at present there does not seem any good result. [F. V. T.]

Melolonthidæ (Chafers).—The family Melolonthidæ are popularly called Chafers, or May, June, and Summer Bugs. Their larvæ are spoken of as 'White Grub'. They are mostly harmful to agriculture and forestry, both larvæ and adults doing damage, the former to the roots, the latter to the foliage. Different species occur all over the world. They can at once be told by their lamellate antennæ, the last segment being composed of flat leaf-like plates which spread out fan-like. The females have a horny, curved ovipositor, and the wing cases do not completely overlap the body. The grubs are all very similar. They are white, curved, with the posterior end swollen into a bladder-like sac, and with a large brown head with powerful jaws, and six legs on the first three segments.

The different species of larvæ may be told by the sculpturing of the mandibles. For detailed life-history see MELOLONTHA VULGARIS, RHIZOTROGUS SOLSTITIALIS, and PHYLLOPERTHA HORTICOLA. [F. V. T.]

Melon, Cucumber, Gourd, Pumpkin, &c., names for plants of the order Cucurbitaceæ. The cultivated, climbing or creeping annual plants that fall into this position constitute a very natural and constant assemblage that may be described as characteristic of tro-

pical and warm temperate agriculture and horticulture. In the countries of their extensive production they often assume a position of considerable importance. Only a few reach the temperate tracts proper, and even these require to be raised under frames, and when transplanted into the open, necessitate protection during the early stages of their growth. Many of the species are highly purgative, such as the well-known Colocynth; but indeed most become only palatable through cultivation, and in their unripe condition or wild or feral states, are often highly suspicious if not even dangerous. The seeds of most species yield a bland oil, and indeed some forms are specially grown on account of their edible or oil-yielding seeds. The following, in alphabetical sequence, are the chief species and cultivated races:—

1. *Benincasa cerifera*, Savi (the White Gourd Melon or Chinese Wax-gourd).—This is extensively cultivated in China, Japan, Java, India, Africa, &c. It is an extensive climber, essentially tropical, usually met with climbing over the roof, or on a special trellis constructed in front, of the cultivator's dwelling-house. In India it is sown at the beginning of the rainy season (June), and continues to bear for some months. The fruit becomes large (often 1 ft. or more long, ½ ft. thick, and rounded at both ends), and when ripe assumes a greenish-white surface, owing to the formation of a waxy bloom. It may be preserved for a considerable time, being often simply left where it grew till required. It is eaten as a vegetable after being boiled, or it is cut up into smaller pieces and cooked in curry. Occasionally it may be met with candied and sold as a sweetmeat, known as *Leshmi*.

2. *Citrullus vulgaris*, Schrad. (the Water Melon), which in India is known as *tarbuza*, appears to be the *Anguria* of the early herbalists and the *Bathiec* of the Arabs; was probably originally a tropical African plant, though now extensively cultivated in all warm dry countries—Egypt, India, China, America — the United States more especially, &c. It is a climbing, or rather crawling, plant, which in India is sown in January to February, and ripens its fruits in the beginning of the hot season (April–May), though there is a special crop, known as *kalinda*, that is sown in June and ripens in October. In fact, on the western side of India the autumn crop is the more important. The Water Melon is most frequently grown on the sandy beds of rivers (prior to the rise of the water level in June), where plenty open space can be given it to crawl over, and a copious supply of water is readily available. In Bikanir and other sandy countries a special form is grown which half buries its fruits. The Water Melon is mainly eaten as a refreshing fruit, and the red-pulped forms seem most highly prized. But the abundant juice is often utilized in the preparation of sherbets (or cooling drinks), and the seeds are said to afford so much oil that it is sufficiently cheap to be employed for burning purposes. A special form known as var. *fistulosa*, and called *dilpasand* in northern India, is cultivated from April to October. It is eaten as a vegetable (not a fruit), and for that purpose is cut up into slices (the seeds being previously removed), then boiled first in water and then in milk, when it is ready for use; or it may be cooked in curry or pickled or candied.

Reference has been made above to the Colocynth (*C. Colocynthis*, Schrad.), but it may be here added that this exists as a wild plant in India, Persia, &c., and that the London supply comes chiefly from Smyrna, Trieste, France, and Spain, more rarely from Persia and India. The Indian fruit has a much thinner pulp than the others named, and cannot be separated from the rind. The supplies reach market from November to January.

3. *Cucumis*, a genus which embraces some twenty-five species, of which more than half are recognized as African plants, and only four are Indian; but of these, two are by far the most important economically, viz. the Melon and the Cucumber.

(*a*) *C. Melo*, Linn., the Sweet Melon (known to the ancients as *Pepon*, *Melopepon*, &c.), is the most valuable agriculturally of the whole family of cucurbitaceous fruits. It has been grown in Europe since classic times, but only within the past three or four centuries has its production been at all extensive. To-day it is grown in Sardinia, Italy, Greece, Spain, France, England, and on a very large scale in America and Australia, &c. The fruit within the past couple of decades or so has been carried to all the industrial centres of the world, and with the banana has become a fruit of the peasant. In Asia, Africa, and Egypt it is (and has for many centuries been) extensively cultivated on the sandy banks of rivers, and on all open sandy and loamy soils where a liberal supply of moisture exists below the surface. An extreme manifestation of these conditions may be mentioned in the floating gardens, constructed on the lake of Kashmir. Melons are there grown on an extremely shallow soil, and the roots penetrate almost to the water. So again Quetta, of Indian localities, is noted for its melons; and in that country water is carried by drains a little below the surface from plantation to plantation, wells being dug to act as reservoirs at stated intervals within the network of distributing channels. If carried on the surface by open drains, the water would be rapidly absorbed by the thirsty soil and parched atmosphere. In consequence of the subsoil circulation thus established, the burned-up country speckles with oases of orchards in which the grape and the melon luxuriate. Thus it may be said the melon can be grown in temperate countries (since being an annual it is unaffected by the severity of the winter) provided the heat of the summer months be sufficient. The finest melons in the world, in fact, are those of Bokhara and Kabul, especially the form called *sarda*, which ripens late in autumn and thus obtains a touch of frost during the last stages of its growth. In warm tropical sandy tracts, pits are generally dug, richly manured, the seeds dropped within, and the pits surrounded by a hedge of thorns or grass to protect the seedlings from drifting sand. The fruits come into season from April onwards, till the plants are washed away by the rise of the rivers in June. One

of the most noted of Indian melons is the *safedah*, or white melon of Lucknow. It is of the size of a very large orange, flattened at both ends, and white inside and out. There are, in fact, many forms of melons, that differ in size, shape, and colour. The surface of some is smooth, of others ribbed or warted, but it is generally admitted that those with greenish-white pulp (flesh) are the best.

In India and other tropical countries there are two special varieties of the species, and these deserve separate consideration, viz. var. *Momordica*, the *phut* or *phunt*. This is a cylindrical fruit, smooth, mottled yellow and green, and more like a cucumber than a melon in shape, but less scabrous. This is grown in cotton and maize fields, and on ripening the fruit bursts, exposing its mealy flesh, which, eaten with sugar, is distinctly good, but otherwise is mawkish. Var. *utilissima*, the *kakri*.—This melon also approaches the cucumber in shape and general appearance, only that it is very much larger, being often 3 ft. in length. It is cultivated all over India during the hot weather and rains, and prefers a dry, loose, open soil. It is an important vegetable, and comes into season long before the cucumber. When ripe it is eaten raw or after being cooked in curry, and when young is extensively pickled.

(*b*) *C. sativus*, Linn. (the Cucumber).—There are in India two primary forms of this plant, viz. a creeping field crop of the hot weather, and a garden climber of the rainy season. Prominence may be here given to these two, since there seems little doubt the cucumber came originally from India, and all the cultivated states that now exist throughout the world have very possibly been evolved from one or other of these. The former has small egg-shaped fruits and is the *gerkin* or *gherkin* of many writers (more especially of the West Indies); it is sown in February to March on drills. The latter—the garden plant—has much larger and longer fruits, dark-green to creamy-white, changing as it ripens to rusty-brown. It is a curious circumstance, however, that so completely has the garden plant been changed by cultivation in Europe and America, that most of the prized forms there produced cannot be grown in India without rapidly deteriorating.

4. *Cucurbita maxima*, Duchesne (the Squash Gourd, Turban, Yellow Poteron, Red Gourd, Ribbed Gourd, &c.).—This produces the largest cucurbitaceous fruit known. It is cultivated in most warm parts of the globe. The fruit is employed as a vegetable, and when mature will keep for months, if hung up in an airy place, and eaten by daily slices, without the stock going bad. *C. moschata*, Duchesne (the Musk Melon, Melon Pumpkin, &c.).—There are two forms of this, one bearing smooth, the other fluted fruits. The former is oblong, the latter flattened spheroidal. It is widely cultivated in both hemispheres, and requires a warmer climate than either of the other two species. It is grown as a field crop, and the yellow flesh extensively cooked and eaten as a vegetable. There is a small form grown in India, and there known as *tendu*, which is much appreciated as a vegetable when cooked in the half-ripe stage. *C. Pepo*, Linn. (the Pumpkin, White Gourd, Knotted Poteron, &c.).—This is called in India *kumra*, where it is extensively grown in gardens as a vegetable, and seen mostly scrambling over the cultivators' huts. In Europe and America, on the other hand, it has become a field crop, the plants being placed 12 to 15 ft. apart. The fruit is oblong, but varies both in shape and size considerably. It is used for soups and stews, or is baked along with apples in pumpkin pie. An egg-shaped form, often known as the Succude Gourd or Vegetable Marrow, is believed to have come from Persia. The fruit when fully ripe is slightly ribbed, and becomes about 8 in. long. It is specially valued as a vegetable when about half ripe, and in that stage more especially it receives the name of vegetable marrow. It is then simply boiled, and served in rich sauce. Within recent years it has so increased in popular favour, that it may be spoken of as one of the chief autumn vegetables in Europe and America.

5. *Lagenaria vulgaris*, Seringe (the Pilgrim's Gourd, Bottle Gourd, Trumpet Gourd, Calabash, &c.), a climbing plant found wild in India, the Moluccas, and Abyssinia. As the result of cultivation this assumes almost any desired shape. It is extensively grown in India, China, Australia, New Zealand, Central and South Africa, America, &c. In India it succeeds best on heavily manured soil, and as a rule two sowings are made a year, the first in April and the second in June. The fruit is extensively eaten as a vegetable, much as with vegetable marrow. The dried shell of certain forms is much employed as water or oil bottles, and this usage can be traced into classic times; but they are also used as sounding-boards for certain musical instruments, and more recently as smoking-pipes.

6. *Luffa acutangula*, Roxb., is the *taroi* of India, a plant extensively grown as a vegetable and highly esteemed by the people. *L. ægyptiaca*, Mill. (the Towel Gourd), is a prolific climber, very prevalent in India as a wild plant, but often grown as a vegetable, the young fruits being eaten. The fully-formed fruit becomes so fibrous that it cannot be eaten, but is used in the production of natural brushes or sponges. The close vascular network, left behind on the fruit being decomposed, as it remains suspended from the tree on which the wild plant had climbed, is the so-called brush or towel. These may be seen in countless numbers all over the regions where the plant is at all abundant, and are collected, washed, and sent into market. They are used as scrubbing-brushes, are employed to strain wine, are made into boot-socks, and recently in Germany have been utilized for stuffing saddles, and in France to line helmets. The supply from India alone might be described as limitless, and it is surprising the rapidity with which these 'loofahs', as they are called, have invaded the markets of Europe and America. [G. W.]

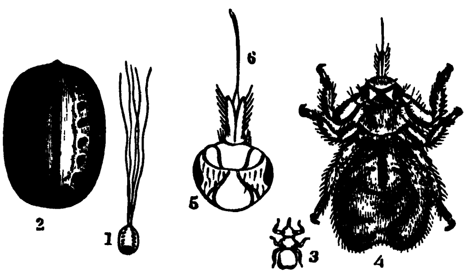
In this country good-quality melons can only be produced in efficiently heated glasshouses and frames. In many particulars the cultiva-

tion required resembles that advised for cucumbers (which see), the most important differences being referred to hereunder. The soil for melons must be of the very best quality, that obtained from an old cattle pasture and stacked for a few months being preferred. Manure should not be added, as this is more conducive to the production of leaves than of fruit. A heat must be maintained equal to that needed for cucumbers, but with the important difference that the atmosphere requires to be drier. The male and female flowers of the melon are distinct, and artificial fertilization, which should be performed on a fine day when plenty of ventilation can be given, is imperative. When grown on a trellis the fruits require artificial support, the method of employing nets being a very good one. For early and late crops it is usual to limit the plants to a single stem, but in mid-season the plants may be allowed to develop more growth with advantage. Plants grown on the single-cordon system are planted 1 ft. apart, 2 ft. being allowed for double cordons. Between three and four months from the time of sowing is the average time required to ripen fruits. Melons need plenty of water at the roots, and frequent syringings when they are making this growth; but at the time of flowering, and during the ripening process, the amount requires to be reduced. Red spider is the most troublesome insect pest, and this is best kept in check by frequent syringings. There are three classes of varieties of melon—the scarlet, the white, and the green fleshed. There are a large number of excellent sorts, and of these Frogmore Orange (scarlet), Hero of Lockinge (white), and British Queen (green) are good representatives. [W. W.]

Melon. — Parasitic Fungi. — The different varieties of melon being closely related to the cucumber, and grown under much the same conditions, are attacked by almost the same parasites (see CUCUMBER — PARASITIC FUNGI). Downy Mildew (*Peronospora cubensis*) covers the leaves and causes them to become yellow. Leaf Blight, which may extend to the fruits, is accompanied by several fungi; the best known in Britain is Leaf Blotch (*Cercospora melonis*), a disease destructive to cucumber. Damping off sometimes causes trouble amongst young plants (see art. DAMPING OFF).

Treatment.—This is the same as with cucumber troubles. It consists in starting with frames or houses as clean as washing, fumigation, and fresh soil can make them. Spraying with Bordeaux mixture of medium strength (see FUNGICIDES) is said to be effective in promoting healthy growth of young plants, but owing to density of foliage is less efficient on full-grown plants. Injuries to the fruit should be avoided, as these promote growth of moulds. After the crop is secured, care should be taken to burn all remains and to clean the house. [W. G. S.]

Melophagus ovinus (the Sheep Spider-fly or Ked Louse) lives amongst the wool, and is very annoying to lambs. They are more or less abundant from March to October, when oval shining bodies, like the pips of small apples, and similar in colour, may be found attached by the pointed end to the wool (shown in fig. 1, fig. 2 being the same magnified); these are not the eggs but the puparia, which are laid by the female, and are at first soft and white. From these issue the flies (fig. 3, 4 the same magnified), which are horny, bristly, and rusty-ochre; the head is orbicular, with two dark eyes (see 5, greatly magnified), and a rostrum in front, enclosing three fine curved tubes (6) for piercing the skin and sucking the blood; the body is large, leathery, purse-shaped and brown above, whitish below, when alive, notched at the apex; the six legs are stout, very bristly, and the feet are furnished with strong double claws. The true ova hatch in the parent's body, and the larvæ mature there. As a rule, four puparia



Sheep Spider-fly (*Melophagus ovinus*)

1, 2 (magnified), Puparia attached to strands of wool. 3, 4 (magnified), Adult insects. 5, 6, Head (greatly magnified)

are laid by a female, but Taschenberg says as many as eight. The adult comes forth in from three to four weeks. The winter is passed in the puparium stage. The insects get on to the sheep from the ground and by actual contact, especially on to lambs from the ewes. A wash of arsenic, soft soap, and purified potash; a decoction of tobacco; train oil, with spirits of turpentine; or mercurial ointment, will destroy the keds. Dipping, to be successful, wants to be done twice in succession at a month's interval. Various patent dips are now used for this purpose. [J. C.] [F. V. T.]

Mendel, Gregor Johann, was a native of Austrian Silesia, being born at the village of Heizendorf, near Odrau, in 1822. He belonged to the peasant-farmer class, but when twenty-one years of age decided to enter the Roman Catholic Church, and after four years' training at the Königskloster at Alt Brünn was ordained a priest. Later, in 1851, he went to Vienna, where he studied natural sciences, mathematics, and physics, for three years. Here he appears to have become especially interested in the problems underlying the transmission of hereditary characters, and when he returned to his old Cloister, in 1853, began a series of experiments to determine the results of crossing different varieties of garden peas. Varieties differing in height, colour of flowers, and other features were crossed, and careful records were kept of the distribution of the parental characters among the offspring of these crosses.

In 1865, after ten years' work and observation, Mendel announced his results and the conclusions deduced from them in a paper

entitled Experiments in Plant Hybridization, which was published in the Proceedings of the local natural history society at Brünn. In this communication he gave an account of a 'law of heredity' (now associated with his name, and discussed below) which ranks among the most important of all biological discoveries. It was not, however, until 1900 that Mendel's conclusions were brought from their obscurity, when De Vries in Holland, Correns in Germany, and Tschermak in Austria almost simultaneously and independently obtained experimental results very closely agreeing with those which Mendel had made known thirty-five years before.

Mendel for a time carried on hybridization experiments with species of hawkweeds, campions, and thistles; but after he was appointed prelate or head of his Cloister in 1868 he does not appear to have had opportunity to complete his researches on these plants, and beyond a preliminary account of the work with the hawkweeds (Hieracia), published in 1869, no further communications of results of hybridization were made. He died in 1884 at the age of sixty-one. [J. P.]

Mendelism (General Principles).—Fundamentally important conclusions in regard to inheritance were reached by Gregor Johann Mendel in 1866, but his publication of these was practically buried in the Proceedings of the Natural History Society of Brünn, and remained unknown for thirty-four years. In 1900 the botanists De Vries, Correns, and Tschermak published papers, independently, confirming Mendel's chief results, and since then there has been great activity of experiment, most notably on the part of Bateson and his *collaborateurs*. The bearing of Mendel's principles of inheritance on plants will be discussed in a separate article, but for the sake of clearness we must begin here by referring to the experiments on peas which led Mendel to his epoch-making discovery.

Mendel worked chiefly with the edible Pea (*Pisum sativum*), which has well-marked varieties and is habitually self-fertilized. He made crosses (hybrids, he called them) between varieties which differed markedly as regards a pair or several pairs of characters, *e.g.* tall or short, with rounded seeds or wrinkled seeds, with yellow cotyledons or green cotyledons. Let us take the case of two varieties differing in stature, the one a giant of 6 to 7 ft. high, the other a dwarf, ¾ to 1½ ft. high. These were crossed, and the resulting seeds grew into plants which were *all tall.* The character of tallness which appeared in this cross-bred generation (F_1) to the exclusion of dwarfness was called by Mendel the *dominant* character, the other being *recessive.* The tall cross-bred peas were left to self-fertilize, and in their progeny (F_2) there were talls and dwarfs, in the average proportions of 3 : 1. When the dwarfs of this F_2 generation were allowed to self-fertilize, their offspring were *all dwarfs*, and further generations bred from them were also all dwarfs. In other words, one-third of the F_2 generation were quite pure as regards dwarfness. They may be called pure recessives. But when the talls of the F_2 generation were left to self-fertilize, their offspring (F_3) were of two kinds: (*a*) plants which produced talls and dwarfs in the 3 : 1 proportion, and (*b*) similar plants which produced *talls only*, being pure as regards tallness. These 'impure dominants' (*a*) and 'pure dominants' (*b*) occur in the ratio of 2 to 1. Thus the F_2 generation, resulting from the self-fertilization of the cross-bred forms or hybrids, consists of 25 per cent pure dominants, 50 per cent impure dominants, and 25 per cent pure recessives.

The results may be expressed in a scheme:—

Parental generation,	Tall variety		Dwarf variety
First filial (hybrid) generation (F_1),		All the offspring were tall; self-fertilized they yielded	
Second filial (inbred) generation (F_2),	25 % Talls (pure dominants)	50 % Talls (impure dominants)	25 % Dwarfs (pure recessives)
Third filial (inbred) generation (F_3),	Talls	25 % Talls (pure) + 50 % Talls (impure) + 25 % Dwarfs (pure)	Dwarfs

Or, if we use D for the forms with the dominant character, R for the forms with the recessive character, and D(R) for forms with the dominant character expressed but the recessive character latent, the facts may be stated in a more generalized way thus (after Punnett):—

Parents,		D R	
First filial generation (F_1),		D(R)	
Second filial generation (F_2),	1 D + (pure dominants)	2 D(R) + (impure dominants)	1 R (pure recessives)
Third filial generation (F_3),	D	1 D + 2 D(R) + 1 R	R

Let us now take an illustration from among animals. When what are called waltzing mice are crossed with normal mice, the hybrid progeny (F_1) is normal. That is to say, the waltzing habit is *recessive*, the normal is *dominant*. When the members of this generation are inbred, their progeny (F_2) consists of normal mice and waltzing mice in the proportion 3 : 1. The recessive waltzers of this generation are quite pure as regards waltzing, and will produce only waltzers for as many generations as one likes to breed them. But the dominants of the same generation turn out to be of two kinds—though they appear to be all the same as far as the eye can tell—one-third of them (*pure dominants*), when inbred, will yield only normal mice, the other two-thirds (*impure dominants*) will split up again, when inbred, into normal mice and waltzing mice in the old proportions of 3 : 1. Another form of the scheme may be used:—

D × R
D(R) .... F_1
1D : 2D(R) : 1R .... F_2
D 1D : 2D(R) : 1R R .... F_3
D D 1D + 2D(R) + 1R R R.. .... F_4

But Mendel not only discovered this remarkable law, which applies to certain kinds of hybridization, he gave a hypothetical rationale of the facts. This rationale is based on the supposition that the generative cells or gametes produced by the cross-breds (F_1) are of two kinds, each kind bearing only one of the two contrasted or alternative characters, which, as we have seen, do not blend. Mendel supposed that the two kinds are produced on the average in equal numbers. Thus 50 per cent carry the quality of tallness and 50 per cent carry the quality of shortness, whether they be female germ cells or male germ cells. Suppose then that each of the hybrids of the F_1 generation produces 50 per cent of its germ cells bearing the dominant character and 50 per cent bearing the recessive character, then, if fertilization is fortuitous, 25 per cent of the fertilized egg cells will bear only the dominant character, 50 per cent will bear both the dominant and the recessive character (only the former being expressed in development), and 25 per cent will bear only the recessive character. This is called *the theory of the segregation of pure gametes*, and it is the corner-stone of Mendelism. A scheme may make it clearer:—

D♀ × R♂	D♀ × R♂	*Pure-bred parents*
D(R)♂ producing sperm cells	D(R)♀ producing egg cells	*Hybrid offspring*
say 100 D and 100 R	say 100 D and 100 R	

Then, if the fertilization is fortuitous, the possibilities are:—

50 D D + 50 D R + 50 D R + 50 R R;

resulting in adults in the proportion,

1D + 2D(R) + 1R.

Mendel's simple hypothesis explains the definite proportions, 1D + 2D(R) + 1R, observed when D and R are crossed. It has been tested in various ways, *e.g.* by crossing D(R) with D or with R, when, as the hypothesis demands, equal numbers of D(R) and D or of D(R) and R are obtained.

In his exceedingly clear exposition of Mendelism (1905), Mr. R. C. Punnett states the characteristic Mendelian result thus: 'Wherever there occurs a pair of differentiating characters, of which one is dominant to the other, three possibilities exist: there are recessives which always breed true to the recessive character; there are dominants which breed true to the dominant character and are therefore pure; and thirdly, there are dominants which may be called impure, and which on self-fertilization (or inbreeding, where the sexes are separate) give both dominant and recessive forms in the fixed proportion of three of the former to one of the latter'.

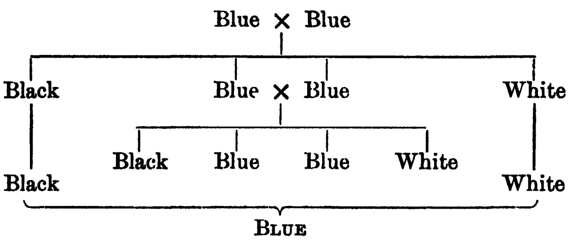
Bringing the theoretical interpretation into prominence—that is, the theory of gametic segregation—Mr. Bateson says: 'The essential part of the discovery is the evidence that the germ cells or gametes produced by cross-bred organisms may in respect of given characters be of the

pure parental types, and consequently incapable of transmitting the opposite character; that when such pure similar gametes of opposite sexes are united in fertilization, the individuals so formed and their posterity are free from all taint of the cross; that there may be, in short, perfect or almost perfect discontinuity between these germs in respect of one of each pair of opposite characters'. This idea of the segregation of the dominant and recessive characters in the germ cells is the essence of Mendelian theory.

Before we pass to illustrations of Mendelian inheritance we must point out that when the original parents differ in two pairs of characters instead of in one, the formula (which Mendel worked out) is a little different numerically, though the same in principle. A tall yellow-seeded pea crossed with a dwarf green-seeded pea, had tall yellow-seeded progeny—these being the two dominant characters. In the next (F_2) generation, out of 16 plants there will be 9 yellow talls, 3 green talls, 3 yellow dwarfs, and 1 dwarf green. The reason is plain: of the 16 there must be 12 tall and 4 dwarf; of the 12 tall there must be 9 yellow and 3 green; of the 4 dwarfs there must be 3 yellow and 1 green. Thus the formula is 9 Dd : 3 Dr : 3 Rd : 1 Rr, and this ratio may readily appear as 9 : 3 : 4 when it is impossible to separate the last two terms on external appearance. Thus when a rabbit of the wild grey colour is crossed with an albino, the offspring (F_1) are all grey; and on being bred together yield in certain cases greys, blacks, and albinos in the proportion of 9 : 3 : 4—a case which has been very satisfactorily cleared up by the experimenters.

Mendelian phenomena of inheritance have been observed in a number of animals, and the list is sure to be increased. Some cases are more convincing than others as regards the numerical proportions and the purity of the dominants. Absence of horns in polled breeds of cattle is dominant to the presence of horns; normal locomotion in mice is completely dominant to the 'waltzing' habit; normal short hair is dominant to the long 'Angora' hair in rabbits and guinea pigs; the short tail of the Manx cat is dominant (somewhat imperfectly) to the normal tail. Very clear cases are presented by poultry—rose comb and pea comb are both dominant to single comb, crest is dominant to no crest, extra toe is usually dominant to the normal four-toed condition, the tendency to go 'broody' and sit on eggs dominates over the absence of this instinct. In regard to colour, there are some very clear results, thus albinism is recessive in rabbits, guinea pigs, rats, and mice; and the unbanded state of the shell in the common snails—*Helix hortensis* and *Helix nemoralis*—is dominant, sometimes completely, sometimes partially, to the five-banded type of shell. A full list of Mendelian cases will be found in Professor Bateson's Mendel's Principles of Heredity, Cambridge, 1909.

A case which illustrates in a vivid way the nature of Mendelian inheritance, and also suggests the practical value of the clue which Mendelism has afforded, is the case of the blue Andalusian fowl. Following Mr. Punnett's account of the matter (Mendelism, 2nd edition, 1907, p. 31), we note that breeders have long recognized the difficulty of obtaining a pure strain, for when blue Andalusians are mated, one-half of the offspring from a pen come blue, one-quarter black, and one-quarter white with black splashes. These proportions suggest the truth that the blue Andalusians are really mongrels, and that the blacks and splashed whites are the pure breeds, which when bred together have all their offspring blue. 'Paradoxical as it may sound, the mating together of the black and the white 'wasters' gives a proportion of blue Andalusians twice as great as does the mating of blue with blue'. Mr. Punnett gives this table:—



Mendelian inheritance is seen in certain kinds of hybridization, where the parent forms exhibit antagonistic characters which do not blend. Its importance is obvious when we note that in the short period since 1900 it has been observed in many different kinds of organisms, *e.g.* in mice, rats, rabbits, guinea pigs, cattle, poultry, canaries, snails, silkworms, and other animals; in beans, maize, wheat, barley, stocks, and many other plants. Recently Hurst has shown that certain types of eye colour in man behave as dominant and recessive to one another. Another fact which shows the importance of Mendelism is the great variety of characters to which it applies—shades of colour, peculiarities of fur and feathers, stature, abnormal features like extra toes, subtle qualities like 'broodiness', 'early ripening', 'immunity to rust', and so on.

We cannot within our limits discuss the implications of Mendelism, but we may point out that like Weismannism (in the idea of germinal continuity) it conceives of the hereditary relation as being in the strict sense between the parental germ cells and the filial germ cells; and like Weismannism (in the idea of determinants) it regards the organism as built up of

a number of definite, separably heritable characters; and that it makes the whole process of evolution more intelligible by removing the old difficulty in regard to new characters being swamped by intercrossing, and by throwing a flood of fresh light on the phenomena of variation and reversion. [J. A. T.]

Mendelism (with special reference to Plants).—In 1865 Gregor Johann Mendel, an Austro-Silesian priest, gave an account of a number of experiments which he had carried on for many years upon the crossing of edible peas. The results he obtained and the law of inheritance which he deduced from them were published in the following year in the Journal of the Society of Naturalists at Brünn, in Austria.

From 1866 to 1900 Mendel's work and conclusions, which rank among the foremost of all biological discoveries, remained in oblivion.

In 1900, however, very similar facts were rediscovered independently by De Vries in Holland, Correns in Germany, and Tschermak in Austria; and since that date the investigation of the problems of inheritance in the light of Mendel's discoveries has led to great advances in the knowledge of descent, and opened up a new field of enquiry which is likely to lead to far-reaching effects in the breeding of plants and animals.

For years Mendel carried on experiments with edible garden peas (Pisum) with a view to determine the laws of the distribution of the parental characters among the offspring when two different varieties are crossed. He was led to select peas for his investigations on account of the fact that they are self-fertile and easily protected from the disturbing influence of foreign pollen, and because many forms are known which possess constant differentiating characters that are readily recognized whenever they are present.

Peas with round seeds were crossed with those having wrinkled ones, tall varieties with dwarf kinds, and forms having yellow seeds with green-seeded sorts; many other crosses were made also. Careful records were kept of the results both in regard to the appearance of the two differentiating characters of the parents in the hybrids or crosses obtained, and also of the way in which the characters were distributed among the offspring of these crosses when the latter were self-fertilized. Mendel found that when round-seeded peas were crossed with wrinkled varieties the resulting plants bore *round seeds only*, no matter which way the cross was made, *i.e.* the result was the same whether round-seeded plants were fertilized with pollen from wrinkled sorts or vice versa.

Mendel described the round character which prevailed and was transmitted with little or no change as *dominant*, the wrinkledness which receded from view or was not visible in the cross-bred offspring being termed a *recessive* character. He discovered that of the other pairs of characters mentioned previously, yellow colour of the seeds was dominant and green recessive, and tallness dominant, dwarfness recessive.

The fact that some of the morphological features of plants and the colours of their flowers disappear, and are not found in the immediate offspring when two different kinds are crossed, was well known before Mendel's time, and was not specially emphasized by him; but no systematic attempt had been made to trace the characters of the original parents of a cross through several successive generations. It was the latter problem which chiefly attracted Mendel's attention, and from the facts obtained in the experimental investigation of it he was enabled to formulate the law of inheritance which bears his name.

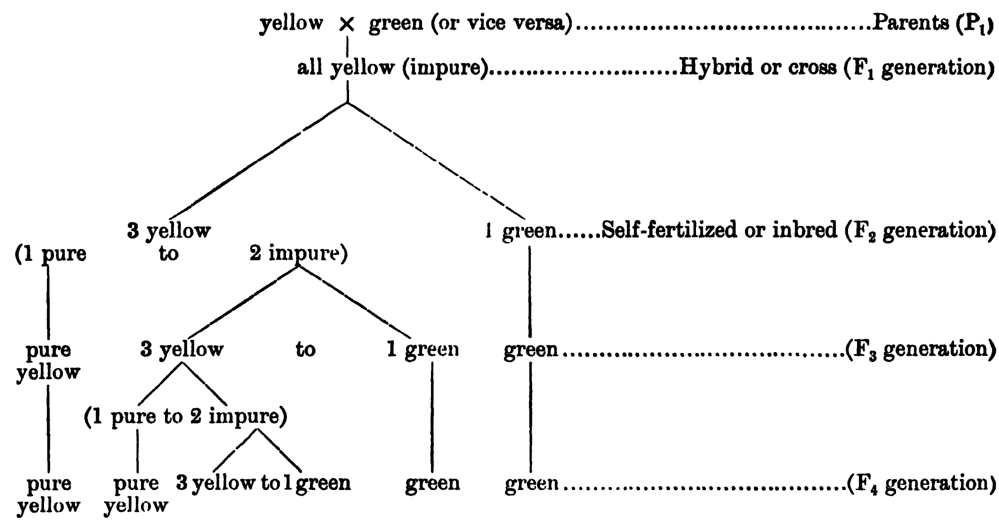
The plants of the first filial generation (or F_1 generation as it is conveniently termed), produced by crossing two parents with different characters, were self-fertilized, and the resulting seeds sown and a crop raised. Mendel found that the individuals of this second generation (F_2) were not all alike: some of them showed the dominant character, while others possessed the recessive character, which, although present in the grandparents, was not visible in the parents of which they were the immediate offspring.

Moreover, when large numbers were raised, he found that the proportion of individuals showing the recessive character to those in which the dominant character was exhibited, was always as 1 to 3; *i.e.* out of every 4 plants obtained, 3 showed the dominant character and 1 the recessive feature.

The following are some of the actual figures obtained: From 258 plants raised by crossing a yellow-seeded variety with a green-seeded kind 8023 seeds were obtained, of which 6022 were yellow and 2001 green, a proportion of 3·01 to 1. Similarly, 253 hybrid plants (round crossed with wrinkled) gave 7324 seeds, of which 5474 were round and 1850 wrinkled, a proportion of 2·96 to 1. The same proportion between dominant and recessive plants was found to hold in the offspring of crosses between tall and dwarf varieties and other kinds possessing opposite pairs of characters. Mendel pursued the matter further, and raised several generations from the dominants and recessives respectively of the second or F_2 generation. Here he discovered that the offspring of those plants showing the recessive character did not vary, but remained constant through many generations; they were pure in regard to this feature, and exhibited no trace of the dominant character in spite of the fact that they were the immediate descendants of parents possessing it. On the other hand, the plants showing the dominant character behaved differently; 1 out of every 3 plants produced pure 'dominant' offspring, while the other 2 yielded dominant and recessive descendants in the proportion of 3 to 1.

The 'results' may be expressed in the scheme on p. 244.

The cross obtained by fertilizing a yellow- with a green-seeded pea, although it appears to possess only the yellow character, in reality carries within it both the yellow and green characters, and these become separated out or segregated in the offspring in a fixed proportion,



namely, three of the dominant yellow to one of the recessive green tint. This is the gist of Mendel's law of inheritance, and is found applicable to a large number of morphological and physiological characters, both of plants and animals.

Mendel was not satisfied with the mere enunciation of the law, but offered a simple and ingenious interpretation of it which has been very valuable in stimulating research and furnishing an explanation of many phenomena of heredity which were previously tangled and obscure.

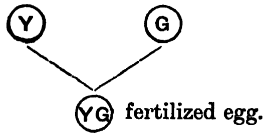
It is well known that in the sexual reproduction of plants and animals two kinds of germ cells or gametes are concerned. In the fertilization process a male gamete unites or fuses with a female gamete or egg, after which the latter develops into a new individual. This new organism, after growth, ultimately produces male and female germ cells. In the case of peas the male cells are found in the pollen grains, while the eggs are within the ovules in the ovary of the flower.

Mendel assumed that each male and female gamete of a cross-bred plant carries one only of the differentiating characters of its parents, not both. For example, when the cross produced by the fertilization of a yellow-seeded sort with a green-seeded kind forms its germ cells, the yellow and green characters which it contains separate out or become segregated among the gametes, each of the latter receiving either the yellow or the green character, but not both. Yellowness and greenness may be treated, therefore, as a pair of unit characters which mutually exclude each other, and the gametes of a hybrid or cross are not hybrid or mixed, but pure in respect of these characters.

In addition to the assumption already mentioned, Mendel further assumed that the number of male germ cells carrying the yellow was equal to that bearing the green character, the same being true of the female or egg cells.

These suppositions being made, the splitting of a hybrid or cross into three dominants (one only of which is pure) and one recessive becomes clear from the following scheme:—

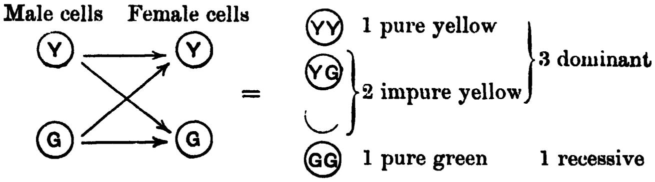
Yellow-seeded variety × green-seeded variety
Male cell × egg cell



Because yellow is dominant over green, the latter develops into an organism bearing yellow seeds, the green although present being not visible. Its germ cells are of two kinds according to Mendel's hypothesis, and may be represented thus:

Male cells	Female or egg cells
Y	Y
G	G

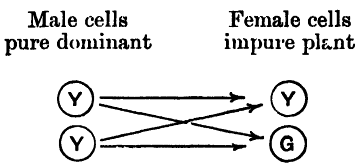
The male cell Y containing the yellow character has an equal chance of uniting with an egg containing the yellow Y or the green character G: if it unites with a female cell Y of like character the offspring will be pure yellow YY; on the other hand, if it meets with an egg G carrying the green character the result will be a cross-bred or impure plant YG. Similarly for the male cell G carrying the green character the resulting offspring will be GG or YG. Allowing the two kinds of gametes to unite at random, the possible combinations and average results would be YY, YG, and GG plants in the proportion indicated thus:—



Since yellowness is dominant to greenness, the impure YG plants would *look like* the pure yellow YY plant, and the proportion of yellow-seeded to green-seeded plants would be as 3 to 1, which Mendel found to be the case.

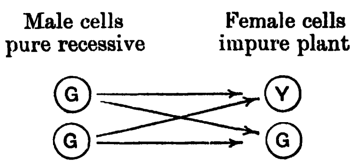
Moreover, one of the three yellow dominants would be pure and breed true, and two would be hybrid or impure, which also agrees with Mendel's observations.

Mendel also found (1) that when the cross-bred plants were fertilized by pollen from the pure dominant yellow-seeded parent instead of being self-fertilized, the offspring were *all* dominant; and (2) when fertilized by pollen from the pure recessive green-seeded parent, half the offspring showed the dominant and half the recessive character. Both these results follow from Mendel's law. In the first case we have—



The possible unions are indicated above, namely two YY plants and two YG plants, both of which contain and show dominant yellow character.

In the second case we have—



or two plants GG and two YG, or half of the total number pure green recessives, half impure yellow dominants.

For purposes of description and discussion of the Mendelian phenomena of inheritance it is convenient to adopt certain terms in order to avoid roundabout modes of expression. The alternative characters which contrast with or exclude each other in the gametes (the unit characters such as 'yellowness' and 'greenness', and 'tallness' and 'dwarfness' of peas) are spoken of as pairs of *allelomorphs*. Possibly in some cases the *presence* and *absence* of a character may be looked upon as alternative to each other, dominance being due to the presence and recession the absence of it.

As indicated previously, a sexually produced plant or animal results from the union of two distinct germ cells or gametes; such an organism is termed a *zygote*. The zygote formed by the union of male and female gametes both of which contain the same character, is named a *homozygote*: it is pure in respect of such character, which may, of course, be either a dominant or recessive one. On the other hand, when the character carried by one of the gametes is different from that present in the other with which it unites, the resulting organism is a *heterozygote*, and is impure or hybrid.

Simple Mendelian inheritance with segregation of characters, as described previously, has been observed among many crossed plants and animals, and a large number of characters have been found to behave as dominant and recessive towards each other. Among plants, the following list of allelomorphic pairs may be mentioned:—

	Dominant	Recessive.
Wheat	Absence of 'beard' or awn.	Presence of awn.
	Rough chaff.	Smooth chaff.
	Red chaff.	White chaff.
	Keeled glumes.	Rounded glumes.
	Flinty endosperm.	Floury endosperm.
	Susceptibility to rust.	Immune to rust.
Peas	Tall stems.	Dwarf stems.
	Yellow cotyledons.	Green cotyledons.
	Brown-skinned seeds.	White seeds.
	Round seeds.	Wrinkled seeds.
Barley.	Two rowed ears.	Six-rowed ears.

In these and many other instances dominance is practically complete, and the cross shows little or no evidence of the recessive character within it; the latter, however, segregates out in the F_2 generation.

There are a large number of cases in which dominance is incomplete, the hybrid F_1 generation exhibiting the recessive character in greater or lesser degree. These do not, of course, in any way vitiate Mendel's law, which is one of *segregation*, and not of dominance or recession of characters.

A few striking examples have been observed in which the plants of the F_1 generation are intermediate between the two parents and not like either. They are normal blend forms which nevertheless strictly obey Mendel's law. In such cases the heterozygotes can be distinguished from either of the homozygotes, which was not possible in the simple instances mentioned first in this article, the yellow homozygotes peas being undistinguishable from the

yellow heterozygotes. For example, a long lax-eared wheat like a Talavera form when crossed with a dense-eared *T. compactum* yields plants with ears of medium length, like those of Square-head wheat. These new forms, however, cannot be fixed, since they are heterozygotes and split up in the F_2 generation into long, short, and intermediates, in the proportion of 1 long, 2 intermediate, and 1 with short ears, which would be expected.

A similar peculiarly interesting example of a heterozygote which is a blend or intermediate of the parents is seen in the blue Andalusian breed of fowls. These slaty-blue birds cannot be fixed no matter how long or how closely they may be inbred: they split into 25 per cent black and 25 per cent splashed-white mongrels, which are really the pure parents of the breed, and 50 per cent of the hybrid or heterozygote blue forms. The only way to obtain *all* intermediate eared wheat or *all* blue fowls is to repeat the cross or breed from the mongrels.

Hitherto reference has only been made to *monohybrids* or crosses between forms differing in a single pair of characters. Mendel, however, investigated the results of crosses between parents differing in two pairs of allelomorphs and found that in many instances the presence of one pair does not interfere with the inheritance of the other, but both follow the law of segregation independently of each other. From such cases of *dihybridism* it is possible to obtain new forms of plants, the characters separated in the original parents becoming combined in a different way in some individuals of the offspring.

For example, a round-seeded green pea crossed with a wrinkled yellow variety gives all round yellow-seeded plants in the first or F_1 generation, since roundness is dominant to wrinkledness and yellowness dominant to greenness. In the second, F_2, or self-fertilized generation four different kinds of offspring are obtained, viz.:

round yellow,		round green,		wrinkled yellow,		and wrinkled green,
9	:	3	:	3	:	1

in the proportion indicated. Two of these forms, the round yellow and wrinkled green peas, are new and quite different from the original parents.

That the results follow from Mendel's law of segregation of characters in the gametes is seen from the following scheme:—

Parent Parent

RY × WG

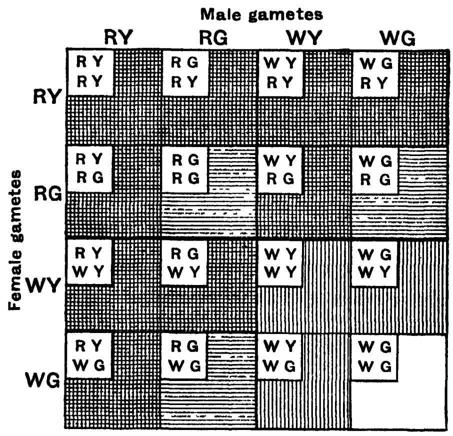
RY/WG F_1 generation.

The gametes of this hybrid are:—

Male	Female
RY	RY
RG	RG
WY	WY
WG	WG

The male cells RY having the round yellow characters in them, have an equal chance of fertilizing any one of the different kinds of female cells, RY, RG, WY, or WG, and similarly for the RG and other male cells.

The possible combinations are therefore:—



If the dominant characters **R** and **Y** are represented by and respectively in the above diagram, it will be seen there are—

9 in which both **R** and **Y** occur (round and yellow)

3 in which the dominant **R** occurs (round and green)

3 in which the dominant **Y** occurs (wrinkled and yellow)

1 in which neither **R** nor **Y** occurs (wrinkled and green)

The single wrinkled green pea is new and will breed true, being pure in respect of both of the recessive characters.

Only one of the nine round yellow peas RY/RY will breed true, all the others being impure, containing either the wrinkled or the green character.

Similarly, it will be seen that only one of the three round green and one of the three wrinkled

yellow are pure in respect of both characters. Of the three last forms, which are the pure individuals cannot be determined by mere inspection: it must be settled by raising a further generation of seedlings from self-fertilized examples.

A proper understanding and application of this result will be of service in the breeding of new forms of plants mainly in making the work of selection less laborious than hitherto, and in giving precision to what was formerly a very haphazard process. A wrinkled green pea which will remain constant can be obtained, as seen above, with certainty in the second generation from the crossing of round green and wrinkled yellow parents; but how many breeders would have abandoned the work on finding that the immediate result of the cross *invariably* gave round yellow peas only.

The raising of the second generation gives it at once, and it can be picked out immediately by mere inspection of the offspring, for where both recessives are visible obviously neither of the dominants can be present.

To obtain a round yellow pea which will breed true from the same cross is not quite so simple; but with a clear conception of Mendel's law the method to be adopted is simplified, and much labour can be saved. The first cross gives a round yellow pea at once; but the breeder would find it addicted to 'breaking up' or 'throwing rogues' when further propagation was attempted, and which of the offspring to discard and which to save would not be clear. The knowledge that one out of every nine must come true is a point gained, and it would not be a difficult matter to settle which individual it is by raising another generation under careful control.

While large numbers of examples of inheritance conform to the simple Mendelian formulæ already explained, there are many cases in which the inheritance does not follow any such simple rules. Some of these exceptions can be explained by assuming that interaction takes place between different allelomorphic pairs of characters, but a considerable residue remains which must be classed at present as 'unconformable cases'. It is possible, and indeed probable, that the law of Mendel is of limited application, certain characters being transmitted and segregated in the gametes of the hybrid, others following another and yet undiscovered law.

That it has been of great service in stimulating and suggesting enquiries into the domain of heredity is evident from the vast amount of research and experiment carried on since its rediscovery in 1900, and that it will very greatly assist the breeder of cultivated plants in the near future cannot be doubted. [J. P.]

Meningitis.—Inflammation of the covering membranes (*meninges*) of the brain or spinal cord produces a variety of symptoms, according to the area affected, and the degree of pressure produced by the excess of fluid which usually results. Pressure on one hemisphere produces paralysis of the opposite side of the body; on the cerebellum, fits or inco-ordination of the voluntary muscles; on the loin, paralysis of the hind quarters. These are but general examples. In the young, particularly in calves and puppies, the form of meningitis is acute, and effusion or abnormal increase of fluid between the cord and the investing membranes suddenly culminates in fits. A more insidious and chronic meningitis affects young horses at grass, and leads to the unsoundness known as 'shivering'. Young stock, unduly forced for exhibition, suffer from a low form of meningitis by which they lose control of the limbs to a greater or less extent. Some of the cases of paralysis in sows after farrowing are due to this kind of pressure on the spinal cord (see PARALYSIS). Dogs, when getting into years, are subject to a special kind of meningitis whose long name explains its nature: cerebro-spinal pachymeningitis, chronic and ossifying. The same results of pressure are seen, but in the dog the chronic ossifying of the dura mater eventually leads to such injury to the cord as to cause permanent and hopeless paralysis or death, save in a few instances where accommodation has been reached despite the impingement of a hard body upon the soft cord. Treatment of meningitis, in whatever form it occurs, is based upon diversion of blood or reduction of blood pressure from the affected structures, and the administration of direct spinal sedatives, placing the patient in a suitable environment, where no excitement or fear or strong light may interrupt recovery. Treatment comprises bleeding from the jugulars in the case of fat young stock; aloes for horses; saline purgatives for most animals. Salicylate of a sodium in doses of 10 to 30 gr. in water has been found most valuable in the case of dogs. The bromides and chloral are the direct spinal sedatives to be preferred. There can be little doubt that meningitis and other diseases of a nervous character have increased with the refinement of the breeds. [H. L.]

Menopon pallidum (Creeping Fowl Louse).—This is the fowl louse which crawls from the fowl, when being plucked, on to the person's body, and which causes some considerable annoyance. It is dull-yellow in colour; on each segment of the abdomen are two pairs of lateral pale dots; the body is oval in the male, more elongate in the female. It is about $\frac{1}{12}$ in. long. It is extremely abundant, and lives on all parts of the body, constantly changing its position. These insects also occur in the nests, and thus they are spread from hen to hen, as well as during copulation with the cock bird. They lay their eggs on the feathers of the birds, and the young, as very pale lice, are also found on poultry. In all active stages they cause severe pruritis and predispose the fowls to other diseases, as well as prevent setting hens from hatching off their eggs. A second species (*Menopon biseriatum*), somewhat larger than the former, is found also on fowls, as well as turkeys, pheasants, and pigeons. Partridges are also subject to these lice, the species in this case being *Menopon perdricis*.

Treatment consists of giving the birds dust baths, and seeing that the houses, nests, &c., are kept clean. Setting hens should be well dusted with insect powder before being placed on the nest. [F. V. T.]

Mensuration is the science which deals

with the practical determination of lengths, areas, and volumes. When certain lines in mathematical figures are known, the lengths of other lines and certain areas and volumes may be calculated by applying the rules of mensuration, which are exact or approximate deductions from mathematical principles. In the practice of farming, problems involving the application of the rules of mensuration are of frequent occurrence. The object of this article, therefore, is to enumerate the more important of these rules, and to give examples of their application in special agricultural cases.

It should be clearly understood that when lengths of lines are expressed in feet, the areas found by the following rules are in square feet, and the volumes in cubic feet. If one length is given in feet and another in yards, then the feet must be brought to yards or vice versa, before the square measure can be ascertained.

I. Mensuration of Areas.

1. Area of triangle = the base multiplied by half the perpendicular from the vertex to the base. In figure 1, area of triangle A B C

$$= \tfrac{1}{2}AD \times BC.$$

2. Area of a triangle when the lengths of the sides are known: from half the sum of the three sides subtract each side separately; multiply the half sum and the three remainders together, and extract the square root of the product. If $S = \frac{1}{2}(AB + BC + CA)$ in fig. 1, then this

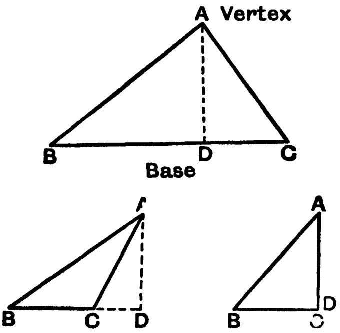


Fig. 1

rule may be symbolically expressed thus: area $= \sqrt{S(S - AB)(S - BC)(S - CA)}$.

3. Area of any parallelogram = any side multiplied by the perpendicular distance from this side to the opposite.

4. Area of any rectilinear figure; divide it into triangles by straight lines which do not cut one another; find the area of each triangle, and add these areas for the answer. If the figure be a trapezoid, *i.e.* a four-sided figure having two of its sides parallel, the area = $\frac{1}{2}$ the sum of the parallel sides × perpendicular distance between them.

5. Circumference of a circle = diameter multiplied by 3·1416 (or more approximately $\frac{22}{7}$).

6. Area of circle = square of radius multiplied by 3·1416 = square of circumference multiplied by ·08.

7. Area of ellipse = semi-diameter major multiplied by semi-diameter minor and by 3·1416.

8. Area of figure with curvilinear boundary: Divide the base (AB in fig. 2) into any number of parts, and measure length of perpendiculars or ordinates through each division.

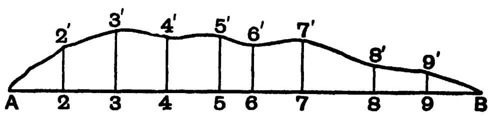


Fig. 2

Find areas of the triangles at each end by Rule 1 above; the remainder of the figure consists approximately of a series of trapezoids, the areas of which are found as in Rule 4. Add all these results together for the total area of the figure.

The above eight rules will suffice for the determination of the area of any figure which is likely to be met with in agricultural practice, and their application will be dealt with in the article on surveying (see Surveying).

II. Mensuration of Volumes.

9. The volume of any rectangular body = its length, breadth, and depth multiplied together.

For example: How many cubic feet and how many imperial gallons will a tank contain 34 ft. long, 12 ft. wide, and 5 ft. 9 in. deep?

$$\text{Volume in cubic feet} = 34 \times 12 \times 5\tfrac{3}{4} = 2346 \text{ cu. ft.}$$

Also, 1 cu. ft. contains approximately $6\frac{1}{4}$ gal.

Therefore, a tank of the above measurements will contain $2346 \times 6\frac{1}{4} = 14650$ gallons approximately.

10. The volume of a prismoid = its mean area multiplied by its depth.

For example: To find the content of a heap of stones (fig. 3). Find areas of base and of top

Fig. 3

according to Rule 3 above. Divide their sum by 2 to find the mean area; or find the mean area by measuring the length and breadth midway up the heap. Multiply the quotient by perpendicular depth. It should be noted that the depth is the perpendicular distance between base and top and not the distance DE measures along the sloping surface from top to base. If the perpendicular depth varies as in dung heaps, the mean depth must be found by sinking a staff at several points and taking the mean of the depths so found. In estimating the quantity of grain in a heap, the cubic contents in feet should first be computed,

and the result multiplied by ·8 for bushels, 5 cu. ft. being approximately equal to 4 bus. In estimating the weight of roots in a clamp, the cubic contents in feet are taken; and under ordinary conditions the weight may be computed by the use of one of the following factors:—

Crop.	No. of lb. per cubic foot.	Cubic Feet per ton.
Potatoes	34	65
Carrots	31	72
Turnips	31	72
Swedes	34	65
Mangold	35	63

11. Volume of a prism or cylinder = area of one end multiplied by the perpendicular distance between the ends.

12. Volume of a pyramid or cone = area of base multiplied by one-third of the perpendicular from vertex to base.

These rules are applicable in finding the volume of stacks, a circular stack being approximately

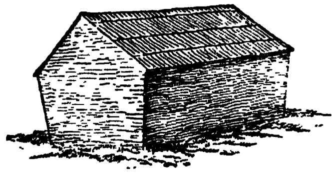


Fig. 4

a cylinder topped by a cone, and a rectangular haystack a rectangle surmounted by a prism. In the case of the rectangular haystack (fig. 4), the length and width are taken in feet at a point about midway between the upper part of the butt and the eaves, an allowance varying from 3 in. in well-trimmed stacks to 8 in. in others being made for the loose outsides. In measuring the height, it is necessary to add to the height from the butt to the eaves $\frac{1}{3}$ of the perpendicular height of the roof in the case of stacks with gabled ends, and $\frac{1}{5}$ in the case of stacks with hipped ends. These factors are not mathematically correct, *e.g.* in the case of a stack with gabled ends (fig. 5), the true cubical content of the prism forming the top would be the area of the base multiplied by $\frac{1}{2}$ instead of $\frac{1}{3}$ as above, but valuers use the latter factor to allow for the difference between the density of the material in the top portion of the stack and that of the lower portion, and also to allow for wastage of material in the tops. A more accurate result would be obtained by finding the volumes of the body of the stack and of the top separately, and adding them together. For

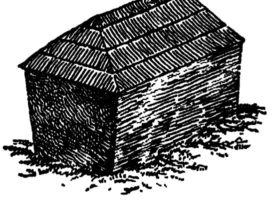


Fig. 5

circular stacks the mean circumference and the perpendicular height are taken between the butt and eaves, and to the latter is added $\frac{1}{3}$ of the perpendicular height to the apex of the roof. The contents will then be found by multiplying the square of the mean circumference by ·08 (Rule 6), and the product by the total height as found above. A more exact way would be to determine the volume of the cylinder and the cone separately and add the two volumes. The weight may then be deduced from the following data, which apply to hay in stack:—

	Cubic Feet per ton.
Light	300
Medium	280
Solid	260
Very solid	240

It should be understood that the above factors will only yield approximate results. It is obvious that age, character of material, mode of stacking, extent of sweating, and also the size of the stack will cause variations. Another method is to use divisors for different conditions of compactness. Thus—

	Square Stack.	Round Stack.
If very compact	÷ 6 ...	÷ 8
If well settled	÷ 7 ...	÷ 9
If not well settled	÷ 9 ...	÷ 11

The quotient gives trusses, and the number of trusses divided by 40 gives tons.

The average weight of different kinds of straw after having been stacked for at least a fortnight are approximately as follows:—

	Proportion of Grain to Straw.	
	Cubic Feet per bushel.	Cubic Feet per cwt.
Wheat	27	30 to 33
Barley	22	35 ,, 44
Oat	18	31 ,, 35
Bean	35	47 ,, 50
Pea	36	44 ,, 48

To find the solid contents of cuttings and embankments. Divide the figure into any number of parallel and equidistant sections as at A, B, C, D, E, F (fig. 6), and find the area of each, and also of a section midway between them; then to the end sections as at A and F add twice the sum of the sections taken at the equidistant parts B, C, D, and E, and four times the sum of the intermediate sections; this sum multi-

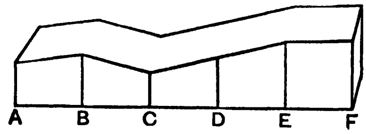


Fig. 6

plied by $\frac{1}{6}$ of the length of one of the parts as A, B, will give the solid content. Where it is required to measure the solidity of earthwork

over large areas of irregular depth, the procedure consists in dividing the surface into triangles, and in multiplying the area of each by one-third the sum of the vertical depths taken at the angles.

For methods of finding the cubical content of round and squared timber see art. on TIMBER, MEASUREMENT OF. [J. B.]

Mentha. See MINT.

Menyanthes trifoliata is the botanical name for an aquatic creeping perennial herb belonging to the order Gentianaceæ, formerly extensively used as a tonic in domestic medicine under the names Bog Bean, Buck Bean, and Marsh Trefoil. The leaves are infused like tea, and yield an intensely bitter extract, which is stored in bottles for use. In Sweden and certain parts of Germany Bog Bean serves as a substitute for hops, 2 oz. of the leaves taking the place of 1 lb. of hops. The plant is often found covering large stretches of spongy bogland and of shallow loch. The underground stems (rhizomes) creep extensively and form interlacing branches with a matwork of adventitious fibrous roots, thus occupying the whole area. The leaves form dense tufts on the ground; each leaf is composed of a long petiole sheathing at the base, and bearing at its apex a leaf-blade constructed like a clover, of three leaflets, which are entire, about 1 in. long and half as broad. The flowering shoots are, on the average, 4 to 8 in. high. Flowering occurs rather early in summer, and now the plant has a very attractive appearance with its raceme of white-and-pink blossoms borne on a naked stalk (scape) sometimes 9 in. long. The corolla is five-lobed, with a tinge of pink externally, but within pure-white, and covered with elegant fringes of hairs. So elegant are the flowers, and so easy is propagation by division of the plant, that Bog Bean is often cultivated in ornamental ponds and lakes.

The distinctive characters of this marsh plant are: (1) Leaf-blade composed of three leaflets (trifoliate); (2) fruit with seeds enclosed in a dry seedcase, which opens longitudinally by two valves (two-valved capsule). [A. N. M'A.]

Mercurialis, the botanical name of a poisonous perennial herb found in woodlands and commonly known as Dog's Mercury. See DOG'S MERCURY.

Merino Sheep.—The Merino is undoubtedly the oldest-established sheep breed in the world, and probably the most widely distributed. Though name is Spanish, the precise origin of this breed is uncertain, and various conjectures, based on circumstantial evidence rather than on historical facts, have been put forward to account for its evolution. Youatt supposed that the Spanish Merinos owed their origin to importations from Italy of the old Tarentine sheep breed, which had originally come from the coast of Syria and the Black Sea. Professor Low (1842) expressed the opinion that the sheep of Spain were employed to produce the earliest type of the Merino. Early writers, such as Columella, establish the fact that the Tarentine sheep were imported into Spain about the beginning of the Christian era, and there seems little doubt also that the sheep of Spain received accessions of African blood from the fine-woolled sheep of the Barbary States in North Africa. Indeed some French authorities maintain that the original home of the Merino was in Algeria, and that the fine wool of the Libyan sheep, to which frequent reference is made by classical writers, was derived from the prototype of the Merino.

Putting aside, however, the question as to its remote origin, we may regard the Merino as the oldest of surviving breeds, and for all practical purposes a creation of Spanish breeders, who employed the finest sheep of Italy and Africa to produce a new type of sheep that should excel all others in fineness of fleece and quantity of wool. The natural adaptation of the Spanish soil and climate was no doubt largely responsible for the successful establishment of this breed in the Iberian peninsula. When the consolidation of the breed took place it is impossible to say, but from what one can gather from ancient writings Merinos were established in Spain before the Moorish conquest. The Moorish dynasty eventually succumbed to the onset of the Spaniards, and under neglect and mismanagement of the latter the fine wool sheep of the country, which had numbered over seven million under the dominion of the Moors, became so reduced that in the days of Philip IV there were only two-and-a-half million Merinos in Spain.

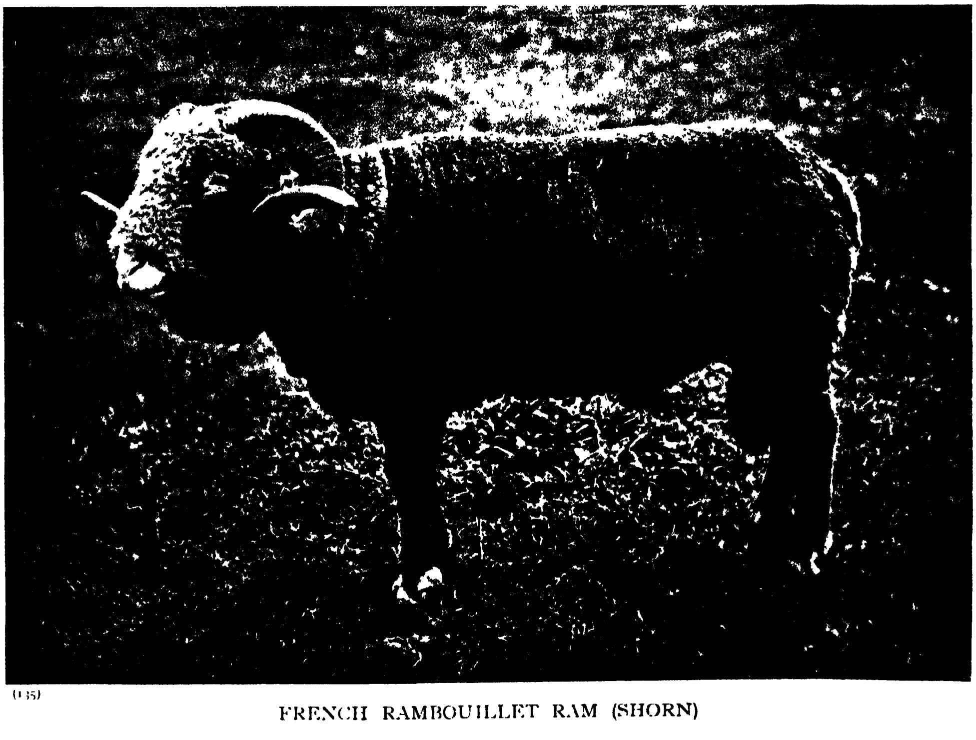
The largest and most notable of these early flocks were centred in Andalusia, Estremadura, and New Castile. With the advance of time two distinct types emerged; one, a small-sized breed, with short legs, long bodies, smooth unwrinkled skin, and wool of short staple but of exceeding fineness. Such was the Escurial breed. The other type, called the Negretti, was characterized by a larger, stronger, and more compact body, and the whole skin much folded. The entire body, save the tip of the nose and the hoofs, was covered with a longer but coarser fleece. During the 18th century the superiority of the Merinos as wool producers became universally recognized, and from Spain were taken the progenitors of all the recognized strains of the present-day Merinos, of which the following is a brief summary.

The FRENCH MERINO takes its origin from an importation of 400 head of sheep selected from the best flocks of Castile, Leon, and the Escurial, and introduced by the French Government in the year 1786. Most of these sheep were placed on the Royal Farm at Rambouillet, and served to found the famous strain of *Rambouillet Merinos.* Under the able management of the French, the Merinos soon excelled in fleece and general type the original stock whence they sprung, though they lost to some extent the hardiness of their Spanish progenitors. The modern French Merino has a fleece of beautifully crimp wool equal to the best Spanish product, and carrying with it a much smaller quantity of yolk.

The SAXONY MERINO, or the Electoral Merino as it is called on the Continent, has sprung from a flock of 300 Spanish Merinos of the Escurial family introduced by the Elector of

AUSTRALIAN MERINO RAM—"DONALD DINNIE"

PURCHASED BY PRESENT OWNER FOR 1200 GUINEAS



(135)

FRENCH RAMBOUILLET RAM (SHORN)

Saxony in 1765, and established by him at Moeglen. The Escurial family had long been noted for fineness of fleece, and this—the only really valuable characteristic of the race—has been carefully fostered by Saxon breeders. Saxon Merinos are of delicate constitution, and hence require great care and attention in their upbringing, but the wool is the finest and perhaps the most valuable of all Merino breeds.

German Negretti Merinos. — Introduced direct from Spain in 1811, the German Negretti has retained all the typical features of the Spanish Merino. It is said that the German Negretti has been evolved by uniting the original Infantando and Negretti families of the Spanish Merinos. The Negretti has the most folded skin of all merino breeds. It is slightly bigger than the Saxon and more robust, but the wool is not quite so fine.

American Merino Breeds.—The origin of the modern American Merinos, with their numerous families and subdivisions, can be traced to two important importations of pure-bred Spanish Merinos. The first of these was made in 1802 by Col. David Humphreys, then Minister to Spain, who introduced into Connecticut 93 Spanish Merinos. From these sheep have sprung the modern families of the Atwoods, Dickinsons, and Black Tops. The second importation, which on account of its magnitude has been most effective in stamping the character of the American Merino, was made in the year 1809, when William Jarvis of Vermont, then U.S. Consul at Lisbon, imported 3850 head of the finest Spanish sheep, derived from the famous flocks of the Paulars, Negrettis, Aguirres, and Montarcos of Spain. Other importations followed rapidly, so that by the end of the year 1810 it was estimated that nearly 20,000 Merinos were established in America. At the present time there are three great classes of Merinos in America—the Modern American Merino, the Rambouillet, and the Delaine.

Modern American Merino.—Originally sprung from Spanish Merinos, the blood of several families has entered into the composition of the modern American Merino. In form it is somewhat inferior to the Delaine and the Rambouillet types, being less hardy, and slower in coming to maturity. But it is superior to these in the production of a fine, strong, heavy fleece, which covers the whole body except the nose and hoofs. Mature ewes clip 12 lb. to 15 lb., while rams yield as much as 20 lb. of wool. It is not a mutton-producing sheep, nor does it come to maturity until three or four years of age. On the other hand, it is long-lived, and does well under varied conditions. It is widely distributed throughout America, and has been exported to Australia and South Africa.

American Rambouillet.—This race has been developed from the French Rambouillet, and was first introduced into America in 1840. It is a much larger animal than the American Merino, and is characterized by the possession of a larger frame, a hardy constitution, and a smooth skin free from wrinkles, except one or two folds on the neck. It is in great favour throughout the western ranges of America on account of its great hardiness, its early maturity, and its prolificacy. But in fineness of wool, in the amount of oil and crimp, and in the proportion of fleece to weight of body, the Rambouillet is inferior as a wool producer to the American Merino. An average clip for ewes is 10 lb., and for rams 12 to 15 lb.

Delaine Merino.—In general appearance the Delaine resembles the American Merino, but the body is larger, heavier, and smoother, and has fewer folds and wrinkles. Delaines vary somewhat in type, and some varieties have no folds at all. They combine mutton qualities with wool production, and are often crossed with the American Merino and the Rambouillet to improve the carcass of the former and the fleece of the latter. The wool of the Delaine is long and somewhat coarse in fibre, but the yield is large, ewes clipping from 9 lb. to 15 lb., and rams from 12 lb. to 18 lb. Several families of the Delaines have been established, notably the Dickinsons, the National Delaines, and the Black Tops.

Argentine Merinos. — In South America, especially in the Argentine and round the River Plate, Merinos have long been established. Pure-bred specimens first landed in Uruguay in 1794, but they were soon lost sight of. In 1813 Halsay had imported 100 fine-woolled Spanish Merinos into the province of Buenos Ayres, but the disturbed state of the country made the establishment of a new breed almost impossible. Indeed the revolution of 1828 caused the dispersion of the Halsay flock, but by this time succeeding importations had resulted in stocking the neighbourhood round Buenos Ayres with Merinos and Merino crosses. The cross between the new imported Merinos and the native *criollo* sheep was termed a *mestizo*. In spite of war and riot, the flocks prospered and grew apace. The great improvement in yield and quality of wool resulted in a general demand for Merino rams, and between 1836 and 1838, 4200 Merinos were imported from Europe. The two principal classes which have served as prototypes of the present-day stock in the Argentine are the Rambouillet and the Negretti, the former being more popular on account of its larger size and greater constitution. Of course the proportion of pure-bred Rambouillets and Negrettis is very small, the great majority of the common flocks being *mestizos, i.e.* sheep which have no other blood in them except that of the early *criollo* and the Merino. During the past few decades the Merino has become increasingly popular in South America, and has largely displaced other breeds like the Lincolns, which at one time threatened to compete with it for the supremacy. In fineness, length of staple, and elasticity, the Merino wools of the Argentine can compete favourably with those from other parts of the world. Probably it is inferior to that of Australia, but greater care in the management of flocks and in the preparation of wool for the market should remedy its present defects. The best wool comes from the interior; along the seaboard the Merino does not give the same return, the wool being looser, the fleece

less elastic, and the staple weak. Within recent years, sheep-breeding in the Argentine has enormously improved, and as an illustration of the degree of perfection which has been reached, it may be mentioned that in 1901 a champion Rambouillet ram was sold for the sum of £1520.

Merinos in Britain.—In Britain the Merino has failed to establish itself, in spite of the various attempts that have been made to implant this breed on our soil. In the 15th century Edward IV is said to have introduced 3000 Spanish Merinos, but all trace of these imported sheep has been lost. In 1787 George III, who was greatly interested in this breed, attempted to found an experimental flock at the Royal Farm, but the few sheep, which were secured with great difficulty, proved to be of very inferior quality. But in 1791, having obtained permission from the King of Spain to import typical specimens into this country, King George was presented, by the Marchioness del Campo di Alange, with a small flock consisting of 4 rams and 36 ewes of choice Negrettis. This flock was stationed at the Royal Farm at Kew, and replaced those imported in 1787. This second attempt to establish the Merinos in England appears to have been successful, and the sheep, after being acclimatized, yielded wool equal to any that could be imported from Spain. The flock soon multiplied, and at a sale held in 1804, 45 sheep were disposed of at high prices. Among the purchasers was a certain Captain MacArthur, who bought 6 sheep, which he sent to his farm in New South Wales, Australia.

In 1808 a flock of the finest Merinos of the Paular family was presented to the King of England. Following this, a Merino society was formed in 1811, and great efforts were made to consolidate the breed in England but without success. The reduction of the foreign wool duty about this time made it profitless to cultivate the pure-bred Merinos in preference to the home breeds. This, combined with the fact that the crosses between the English breeds and the Merino were less hardy than the native sheep, was largely responsible for the abandonment of any further attempts to found a strain of Merinos in England.

Merinos in the Colonies.—It is uncertain when Merinos were first brought to the Cape Colony. Probably the first attempt to introduce it into the Colony was made by the Dutch Government in 1724. The result, however, was a failure. By the year 1785 Colonel Gordon, a gentleman in the employ of the Dutch Government, had successfully imported Merinos to the Cape, and had established a breed which served as a parent stock to provide Australia. Again, in 1793 a consignment of a few Merino rams reached South Africa and were crossed with the native fat-tailed ewes, but it does not appear that a definite breed corresponding to the South American *mestizo* was established. On the death of Colonel Gordon, his flock, which numbered 32, was disposed of by his widow, and of these 26 were secured by two Australian colonists, Captain Waterhouse and Captain Kent, who had been sent from Port Jackson to South Africa for stores, and incidentally on a quest for finewoolled sheep. In 1794, 10 of these Merino sheep reached New South Wales and were distributed among some half-dozen individuals, of whom Captain MacArthur was the most important. Captain MacArthur became an enthusiastic breeder of Merinos, and strongly advocated their adoption in Australia, which he foresaw possessed natural advantages for the successful establishment of this breed. It was largely owing to his efforts and his example that the original importations of Merinos were kept pure. The descendants of his flock are still to be seen at Camden Park, New South Wales. In a hundred years the only outside blood introduced has been from a few sheep purchased in 1804 from the Royal Merino flock at Kew. [R. H. L.]

The remainder of this article concerns itself mainly with the development and management of Merinos in Australia.

With the beginning of the 19th century the breeding of Merino sheep may be taken as established in Australia. It is true the breed was by no means in universal favour. Its immense value as a wool producer was not realized by the early pioneers and settlers, who wanted mutton, and preferred the hairy sheep of India and the Cape, which was more prolific. Captain MacArthur, however, set out with the definite purpose in view of establishing a flock of finewool sheep, and although he used Spanish rams for crossing with his mixed-bred ewes of the general flock, he and his descendants have always kept the stud flock pure as above stated. Another of the earliest breeders of Merinos in Australia was Paymaster Cox, to whom Captain Waterhouse sold his flock when he left the colony. The direct descendants of his flock are still in the hands of his grandson, Mr. G. N. Cox of Burrundulla, N.S.W., and his family has also done work of immense value to the pastoral industry of Australia. From about the year 1825 the developments were very rapid, and in particular mention must be made of the work done by the Van Diemen's Land Company. This company spent large sums of money in the purchase of pure-bred stock of various kinds for their holdings in Tasmania. Among others they sent out repeated shipments of Saxon Merinos. The various breeds were kept strictly pure; some of what are now the finest stud flocks in Tasmania were established with imported Merinos when they were cast by the company for old age. Any list of the pioneer breeders of Merino sheep in Australia would be incomplete without mention of Mr. T. Henty, who in the first place established in 1796 a stud flock on his farm in Sussex, England, and who in 1829 sent a large number of Merino sheep of his own breeding in charge of his three sons to Western Australia. Two years later the sons reshipped their stock to Tasmania, where the strain was for many years later as famous as it had been in England, and whence many pure Merinos were supplied for the improvement of flocks in Victoria and South Australia.

According to the latest available returns (1907) there were in the Commonwealth of Australia 87,887,909, and in New Zealand 20,983,772 sheep.

In regard to the distribution of Merinos throughout the States of the Australian Commonwealth, it is impossible, however, to give any exact data, for the reason that no State now keeps separate returns of Merinos apart from other breeds. It is also impossible to arrive even approximately at the numbers from the kinds of wool sold, because although Merino wool is sold by itself, the wool produced in any one State is not necessarily sold at the chief selling centre in that State. For example, last year some 30,000 bales of wool produced in Queensland were sold in Sydney, and in the same year over 96,000 bales produced in New South Wales were sold in Melbourne. Generally speaking, however, it may be said that in the temperate and colder climates the proportion of cross-bred and long-woolled sheep always increases. For example, in New Zealand only 5 per cent of the wool sold is Merino; in Tasmania the percentage rises to 49; in Geelong (Victoria), where a great deal of beautiful cross-bred wool from the rich western and south-western districts of Victoria is sold, the proportion of Merino wool amounts to 56 per cent of the total; in Melbourne 72 per cent of the wool sold is Merino; in Adelaide 90 per cent; in Brisbane 96 per cent; and in Sydney 97 per cent of the wool sold is from sheep of this breed.

Up to the end of 1902, statistics of the various breeds of sheep were kept separately in New South Wales, from which it may be seen that of a grand total of 25,912,472 sheep. 91·8 per cent were Merinos. It must be specially mentioned that during this year, which was one of severe drought in New South Wales, the number of Merinos had decreased by 39 per cent as against the total for the preceding year, whereas the number of cross-bred and other breeds had decreased only 28 per cent as compared with the preceding year.

CHARACTERISTICS OF THE AUSTRALIAN MERINO SHEEP.—Speaking generally, the Merino sheep is characterized, in the first place, by the fineness, density, softness of its fleece, and by its weight of wool (the Merino sheep cuts a greater weight of wool per head than any other known breed), by its extreme hardiness, its ability to do with less feed than any other breed and to travel greater distances to water, and by its habit of grazing in flocks. Merino sheep do not scatter so widely as other breeds, and they may often be seen camped during the day in a compact mass, of which the individuals shelter their heads from the burning sun under the bodies of each other. They are splendidly suited to a dry climate, and as illustrating this point it may be mentioned that they thrive in many parts of Australia where the rainfall is under 5 in. per annum. In such country, paddocks of 100,000 ac. each, in which water can only be found in one place, are often met with, and the sheep travel all over these in search of food, and must necessarily always return to the same spot for water. It is said that they do not thrive on English grasses, but do much better on the natural herbage of Australia.

To give average yields of wool for the breed is almost an impossibility, so much depends upon the season and conditions generally. Under normal conditions, however, such as would be met with on most breeding stations in Australia, the fleece of the grown sheep in the flock would average 8 lb. per head; while the fleece of the lambs, which under the same conditions would be shorn at the age of five months, would average from 3 to 3½ lb. Of course, yields very much greater than these have been obtained. There are cases on record in which highly bred stud rams have cut up to 43 lb. of wool in the grease. A good average for rams is, however, 20 lb. Ewes have been known to cut up to 30 lb., but a good average for a stud ewe would be 15 lb. The average overhead for Merino flocks in Australia is probably in good seasons about 7 lb.

The market value of the wool naturally varies very much in accordance with the demand. During the past thirteen years it has varied from as low as 7¾*d.* per lb. for good average quality in the grease, to as high as 15*d.* per lb.

The Merino sheep is essentially a wool producer, and therefore its carcass is not to be compared with that of other breeds in which, for generations, attention has been paid to mutton as well as to wool production.

In size it is medium, and the mutton is characterized by the closeness of its grain, its darkness in colour, and great sweetness of flavour, in which it resembles very much either the Scotch Blackface or the Welsh mutton. The bones are small and fine, and there is an absence of coarse fibre. The carcasses of Merino sheep are light and small on the leg, and also light on the point of the shoulder. It is at this point that the defects in Merino carcasses as compared with cross-bred mutton occur; there is also a tendency to get excessively fat from the tail to the point of the shoulder. Some of the plain-bodied Merino sheep, however, can hardly be distinguished in the carcass from cross-bred sheep, except by the long thin leg. The range in weight may be taken for ewes and wethers as from 40 to 60 lb. dressed carcass. A great deal depends, of course, on the season, and they sometimes go up to 70 lb. Lambs range from 30 to 42 lb. This wide range is due to the fact that the lambs are killed at any time from three up to eighteen months. In fact, so long as they have lamb teeth they are killed as lambs. For equal live weights, a Merino lamb would give practically the same weight of dressed carcass as a lamb of any other breed, or at most the difference would not be greater than 1 lb. The difference is, however, greater in the grown sheep. The Merino gives more inside fat, and therefore a better yield of tallow, whereas the cross-bred gives more mutton. For equal live weights, the dressed carcass of a cross-bred sheep is from 4 to 5 lb. heavier than that of a Merino, whereas the Merino would give on the average from 3 to 4 lb. more inside fat than the cross-bred. The average yearly top value of mutton has ranged from 2⅝*d.* per lb. in 1896 to 4¼*d.* per lb. in 1898, and was in 1908 3¼*d.* per lb. at Smithfield Market. Australian lamb has ranged from 3⅝*d.* per lb. in 1897 to 5⅛*d.* per lb. in 1904. The average top price for the year 1908 was 5*d.* per lb.

FLOCK MANAGEMENT IN AUSTRALIA.—The

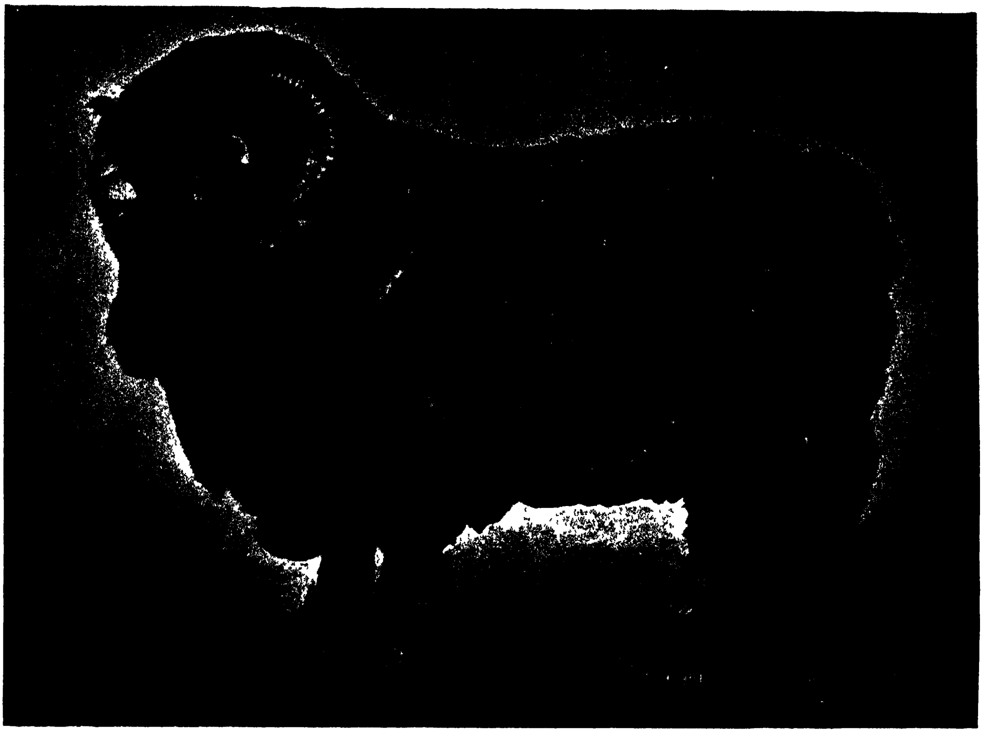
breeding of Merino sheep has been brought to a high art in Australia, and here are probably to be found the most skilful sheep-breeders in the world. In this section it is intended first to give a brief outline of the management of an ordinary flock throughout the year, and then to detail in how far the management of stud flocks would differ.

A typical sheep property may be taken for New South Wales as comprising 50,000 ac., although there are in Queensland properties in which the single paddocks would be double this area, and which would extend to scores or even hundreds of square miles. Let it be supposed that the carrying capacity of our typical property be one sheep per acre. On such a property the breeding stock would number 18,000 ewes. Either spring or autumn lambing would be chosen, one or other method being usually followed on a station and seldom both. In the paddocks the number of rams used is equal to 2 per cent of the ewes, which are joined to the ram in November for the autumn lambing. The rams are left in the paddocks for six weeks, and with the number of rams above stated, lambs equal to 80 per cent of the ewes would be considered a satisfactory drop. On a property of this kind, 1000 ac. would be considered a fair size for each paddock, and in these the ewes are left entirely to themselves, no assistance whatever being given to them at lambing. At the end of the lambing season the sheep are given a week beyond the last possible time of lambing, and then the ewes with their lambs are mustered into the yards in the paddocks, for the purpose of tailing and ear-marking. It is considered bad practice to take the sheep to distant yards, and therefore special mention is made of the fact that the yards are situated in the paddocks. Two ways of tailing the lambs are practised—(*a*) searing with the hot iron, (*b*) cutting with the knife. Of these, the former is undoubtedly the best, as it prevents loss of blood and is aseptic; it also seems to be less injurious and painful to the lambs than the other. At the same time the tup lambs are castrated, and ear-marks are given to all lambs. It may be mentioned that two ear-marks are always put on. New South Wales is divided into 67 sheep districts, and for each sheep station in any one district there is a registered Government ear-mark, and no other property in the district can use that ear-mark. The other ear-mark is given to indicate the year in which the sheep was lambed. The lambs are then permitted to run with their mothers until shearing time, when they are shorn with their mothers. They are then five months old. Immediately after shearing they are weaned, and from then until the next shearing the hoggets may either run all together, or ewe and wether hoggets may be kept in separate paddocks. Sometimes after the second shearing, when they are four-tooth sheep, people begin to breed from them; but it is more satisfactory to let them run on. This practice of joining four-tooth ewes to the ram is more common in the hot western country of New South Wales and in the hotter parts of Australia generally than in the colder climates. In the colder climates the practice is to let them run for another year. They then drop the first lamb just as they become six-tooth sheep. The usual practice is to cull the young ewes in the August before the third shearing. The method of classing is to bring each sheep up to the classer, who examines it for *wool*, *carcass*, and *constitution*. The proportion selected for breeding depends very much, of course, upon the standard fixed by the classer and upon his ability to class to that standard, but in general it may be said that 25 per cent of the young ewes are rejected. Uniformity in the flock is the great desideratum, and is in fact the goal at which the classer aims. On many large stations it is now customary to employ classing experts to class the sheep for breeding. These men are paid for this work at the rate of £3 per 1000 for flock sheep, and £1 per 100 for stud sheep. The advantage to the station of employing an outside man for this work is that he examines the sheep with an unbiased eye, and is less likely to be prejudiced in favour of any individual members of the flock than the owner. This expert classer also does all the mating of the flock, and in classing as well as in mating his decision is final. If any rams are to be purchased from outside flocks, the classer employed by the station is consulted, and he advises in the purchase. On a station such as the example now under review, the practice is to keep a ewe only until she has dropped her third lamb, and then to sell her.

A word as to the disposal of the wethers is necessary. Experience has shown that a wether gives his best fleece at three years old, and many people keep the wethers until after the third shearing and sell them just as they become full-mouthed — that is, at four years. Many other breeders sell the wethers after the second shearing. The price obtained for the wethers is of course a factor in the income of the station. A very great deal depends naturally on the seasons and conditions, but 8*s*. per head off the shears would be regarded as a satisfactory price.

Shearing.—Shearing is, of course, an event of great importance in the squatter's year. The shears have now given place to shearing machines on practically all stations of any size, and on a place of the area given, twenty machines (and twenty shearers) would be employed. These twenty men would shear 1600 per diem. The squatter looks on a shearer who cannot shear eighty sheep per day as being, in his own words, 'not worth pen room'; and at the above rate of shearing, the sheep are very little cut about indeed. In each shearing shed a wool classer is employed, and on every rationally managed station no effort is spared to class the wool into such grades as the market demands, and in such a manner that the owner will receive the highest market value for his wool. An expert wool classer is paid at the rate of 20*s*. per thousand fleeces, and can readily class 3000 fleeces per day. Further particulars given under Wool.

Breeding of Stud Sheep.—On stations such as the example above described, a flock of stud sheep would, however, be kept apart from the



FAMOUS AUSTRALIAN MERINO RAM—"PRESIDENT"

SOLD IN 1896 FOR 1600 GUINEAS

AUSTRALIAN MERINO EWE

ONE OF THE SPECIAL STUD EWES, HARTWOOD STUD, RIVERINA, N.S.W.

general flock. The management of such studs does not differ in any essential from that of the station flock, except that in the stud flock a very high-class animal would be dealt with, and a very high standard of excellence in that animal is fixed. The object of the stud flock is, of course, the improvement of the station flock by ensuring a supply of high-class rams for use with the station flock. Those stud flocks are kept absolutely pure, and of course no flock sheep, however excellent, would ever be taken into the stud. The stud flocks are culled with the greatest care, and mated in an equally painstaking manner. Otherwise the management is similar to that of the flock, with the exception that the sheep are allowed somewhat more room, and naturally are grazed on the best pasture available. The ram lambs, however, when weaned, must shift for themselves. Normally, however, pampering of the sheep in any way is sternly discouraged, and such methods of 'improvement' as artificial feeding or artificial shelter of any kind are not resorted to. Apart, however, from this system of keeping separate stud flocks on stations, there are in Australia, where the breeding of Merino sheep has been brought to a high art, many flocks of stud sheep only, and the breeding of rams has developed into a highly lucrative business. As an instance of the enormous sums of money which such flocks may earn, the Boonoke stud may be quoted, from which the return in the sales of stud sheep in twenty years amounted to £431,660, or an average of £21,583 per annum for the whole period. Even with such studs, however, artificial methods are not usually adopted, except when breeding with the special object of exhibiting at shows, and even then, house-fed sheep are exhibited in special classes by themselves. In Tasmania, where many of the most famous and old-established flocks are kept, stud sheep are put on small paddocks, and the ram lambs are sometimes reared on foster-mothers, chiefly cross-bred or Lincoln ewes, which have more milk than Merinos.

There is no flock book for the Merino breed in Australia, although a somewhat tentative attempt is at present being made to establish one. The owners of all the principal stud flocks have kept their own records. In many cases such flocks, established in the beginning with a small number of sheep, have been bred within themselves for many years. In one case known to the writer, a flock established forty years ago with eighty ewes and one ram has not had any outside blood whatever introduced since its establishment, and the flock to-day, which has all along been carefully classed and mated, is remarkable for the uniformity and quality of the individual sheep. Some of the famous old flocks can be traced back to the sheep originally brought to Australia, although nearly all the studs have been at various times either directly or indirectly improved by the introduction of fresh blood from the famous Rambouillet flocks, from the best studs of Saxony, or by the introduction of Vermont (or American Merino) blood. No controversy has raged more fiercely among the breeders of Australia than that as to whether the introduction of Vermont blood was really of benefit. Many eminent authorities even now hold that the step was a mistake, and that the Vermont has done more harm than good. Be this as it may, the fact remains that some flocks did not come to the front at all until after the introduction of Vermont blood, and instances could be quoted of flocks previously unknown, which since the introduction of Vermont blood have advanced to the very front rank. In one flock, the result of the infusion of Vermont blood was in eight years to increase the yield of wool by 1 to 1½ lb. scoured wool per sheep in average seasons. The sheep was of a type with a great apron, a very much wrinkled body, and heavily wrinkled on the quarters. Experience has shown, however, that the practice of breeding to such a type can be carried to excess, as the increase in wool is accompanied by an altogether disproportionate increase in yoke, and both are obtained at the expense of constitution. In consequence, of late years there has been a return to a very much less wrinkled type of sheep, and now specimens may be seen with smooth bodies and only slight wrinkles on the quarters, and very much less wrinkled about the neck than was formerly fashionable.

SALE OF RAMS.—The chief ram sales were formerly held in Melbourne. They have now, however, drifted to Sydney, where they take place immediately after the show of the New South Wales Sheep-breeders' Association, which is held during the first week of July. Of course, many other sales take place, both privately and through agents; and so much has the fame of Australia as a breeding place of Merino sheep spread, that buyers now visit it from many distant parts of the world. Sales have recently been made to South America, Orange River Colony, and Uruguay, which latter country lately purchased privately a ram at 1000 guineas and several ewes at about 200 guineas each. In 1896 a ram called President (of which we give an illustration) was sold at Sydney for 1600 guineas. Three years later, a ram owned by Mr. Thomas Gibson, and named The Admiral, was disposed of for 1500 guineas, while 1000 guineas was obtained in 1897 for the famous ram Royalist. [J. M. H.]

Merisus intermedius, a small Pteromalid parasite which infests the larvæ of the Hessian fly in Europe. Other species do so in America—*M. destructor* and *M. subapterus.* [F. V. T.]

Merodon equestris (the Narcissus Fly).—The maggots of the Narcissus fly frequently cause considerable harm to the bulbs of narcissi, daffodils, and hyacinths. They burrow into the interior of the bulbs, hollow them out, and speedily cause decay or bad growth. The attacked bulbs may be told early in infestation by the centre stump dying, and a weak side growth is produced. More advanced attack is easily seen, for the bulb becomes soft, and a large hole is made at the base. On opening an attacked bulb, one or more large dirty-white grubs will be found inside. In the latter stages the larvæ are usually found near the crown of

the bulb, apparently making their way towards the surface. When one plant is killed, they can move through the earth to another and enter it.

The fly—the parent of the grubs—is like a small humble-bee, but can at once be told from a bee by having only two wings. It is about ½ in. long, and 1 in. across the expanded wings. The colour varies very much. The head is dark-brown; the thorax black, with a tawny or reddish-yellow or grey band in front and behind, thickly covered with hairs. The abdomen is dark, with dark hairs, except at the tip, where they vary from reddish to reddish-yellow or yellowish-grey. The legs are black and somewhat hairy. The abdominal hairs in life often have a gilded sheen. The fly appears in April and May. They fly by day and deposit their eggs on the bulb, the female having a rather prominent ovipositor to enable her to penetrate the earth. The larvæ on hatching crawl down the bulb, and enter it near or at the base. The adults may be seen hovering over daffodils and narcissi, and when on the wing produce a very audible sound. Some observers say the larvæ enter by working down the neck of the bulb, and eat their way down the centre to the base, and then make the hole so commonly seen. Probably both means are employed by the larvæ in making their entrance, but undoubtedly most do via the base.

The maggot is ½ in. long when mature, somewhat oval in form, smooth-skinned, dirty-white in colour. They are frequently covered with a dirty wet substance and frass. Some reach maturity by November, others not till January. When full fed, the majority pass to the soil and pupate there, but some do so in the bulbs. They form a cell in the earth near the last-attacked bulb, lined with a scanty layer of silk; in this they change to an oval-brown puparium, with two projecting processes in front.

As many as seven young larvæ may occur in each bulb; but as they grow they spread out, and only one or two occur when in the adult stage.

There is no doubt that this pest is on the increase, owing partly to the constant importation from abroad. It has apparently been introduced into this country with Dutch and other bulbs.

Prevention and Treatment.—All diseased bulbs should be burnt. One can usually tell the presence of maggots either by the hole at the base, or by the central area dying, or by pinching the bulb at the top, which, if soft, is almost certain to contain the larvæ.

If there is any uncertainty the bulbs should be placed in warm water for fifteen minutes at a temperature of 115° F., which will kill the larvæ but not harm the bulbs. The Dutch authority Ritsema Bos advises soaking the bulbs for eight days in water before planting. All flies should be caught, and land where they have been present deeply dug when the bulbs are lifted. [F. V. T.]

Mesozoic, a name for the group of rocks and the geological era in which faunas appear intermediate between the older types and those which approximate to the life-forms of the present day. The limits of the Mesozoic group of strata are the base of the Triassic and the top of the Cretaceous system. [G. A. J. C.]

Metamorphic Rocks are rocks that have undergone serious alteration, through the development of new minerals or new structures or both, under the influence of subterranean heat or pressure, or of both causes acting together. Where an igneous mass bakes and induces changes in the rocks penetrated by it, these rocks are said to have suffered *contact metamorphism.* Changes due to pressure, such as the rolling out and crushing of minerals in the rock mass, are said to be due to *dynamic metamorphism.* See arts. GNEISS, SLATE, SCHIST. [G. A. J. C.]

Metayage, or in French legal phraseology *le colonage partiaire*, is a system of letting agricultural land for which the English language possesses no equivalent term. It involves the payment of rent in kind, but that alone does not constitute metayage. Produce-rents may take two chief forms: the payment of a fixed quantity, or the payment of a proportional quantity, and the latter is the distinguishing characteristic of metayage, the yield of the farm being divided in definite proportions between owner and tenant, so that the quantity accruing to each party varies from year to year. Originally and etymologically it was a division by halves, and usually it remains so; but practice now varies so that the share of the owner is sometimes as low as one-third on inferior land, or even as high as two-thirds on exceptionally fertile farms. Besides produce-sharing, another essential feature of the system is that it involves the associated action of owner and tenant in the provision of the stock, for the former generally provides half the movable capital in addition to the land and permanent improvements, though here again the proportions vary according to local custom and the nature of the crop. Usually the metayer is responsible for providing the labour, implements, and half the stock, while the responsibility of management is shared, the discretion of the landlord being exercised in the purchase and sale of cattle and in the general direction of the farm. It thus tends to create a unity of interests between the parties, and is incompatible with absenteeism, while it affords opportunities for cultivation to people who are too poor to provide such a capital as the British farmer requires. It is favourable to stability of tenure, and there are some cases in which farms have been continued for over three centuries in the same family of metayers. The local customs relating to the respective liabilities of the parties, cultivation, cropping, and the like, are authoritatively printed and sold in each district of France, and must be followed, unless they are explicitly set aside in the lease.

For a discussion of the advantages and disadvantages of metayage, see LAND. [S. H. T.]

ANATOMICAL MODEL OF A HORSE—KEY TO REFERENCE NUMBERS

II. SKELETON

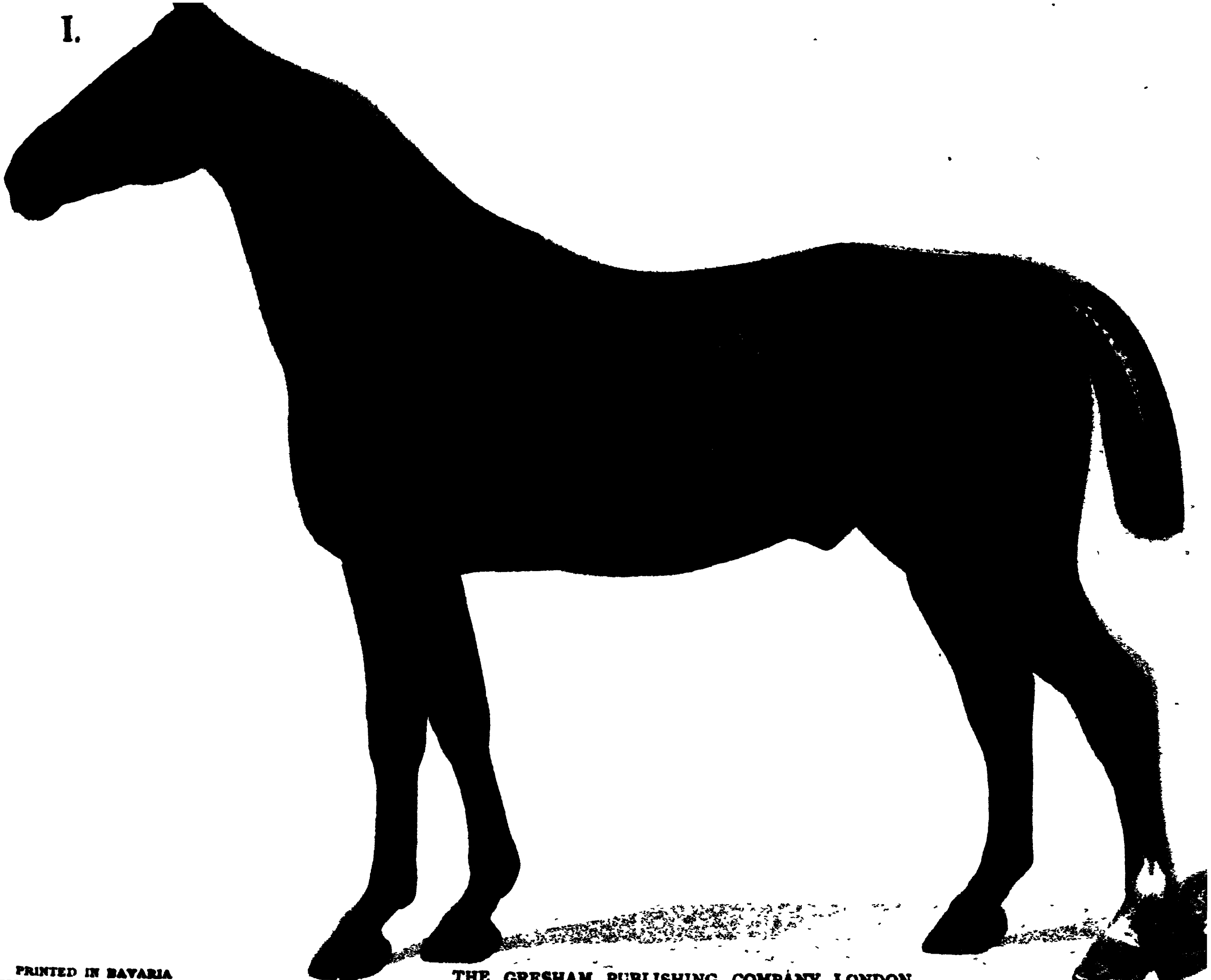
1. Superior maxillary or upper jaw.
2. Inferior maxillary or lower jaw.
3. Occipital bone.
4. Frontal bone.
5. Nasal bone.
6. Molar teeth.
7. Canine teeth
8. Incisor teeth.
9–15. The seven cervical vertebræ.
16–17. The eighteen dorsal vertebræ
18. The true ribs (eight).
19. The false ribs (ten).
20–21. The six lumbar vertebræ
22. The sacrum.
23. The caudal vertebræ (18–20).
24. The sternum or breast bone.
25. The scapula or shoulder blade.
26. The shoulder joint.
27. The humerus.
28. The elbow joint.
29. The radius.
30. The ulna.
31. The carpel or knee-bones.
32. The cannon or shank-bone.
33. The splint-bone.
34. The fetlock joint.
35. The upper and larger pastern-bone.
36. The pastern joint.
37. The lower and smaller pastern-bone.
38. The coffin joint.
39. The coffin-bone.
40. The haunch.
41. The hip joint.
42. The femur or thigh-bone.
43. The patella or knee-cap.
44. The stifle.
45. The tibia.
46. The fibula.
47. The tarsus or hock.
48. The os calcis.

III. BODY

1. Brain:
   a. Cerebrum.
   b. Cerebellum.
   c. Medulla oblongata
2. Spinal cord
3. Tongue.
4. Pharynx.
5. Œsophagus.
6. Diaphragm, anterior aspect
6a. Diaphragm, posterior aspect
7. Stomach.
8. Duodenum.
9, 9. Jejunum and ileum.
10. Cæcum.
11. Double colon:
   a First portion.
   b. Suprasternal flexure.
   c. Second portion.
   d. Pelvic flexure.
   e. Third portion.
   f. Diaphragmatic flexure.
   g. Fourth portion.
12. Small colon.
13. Rectum.
14 Anus
15. Liver.
16. Pancreas
17. Spleen.
18. Kidney:
   a, *a* Pelvis.
19, 19. Ureters
20 Bladder.
21. Urethra.
22. Penis.
23. Spermatic cord.
24. Testicle.
25. Spermatic duct.
26, 26. Vesiculæ seminales.
27. Larynx.
28. Trachea.
29, 29. Lungs cut open, showing bronchial tubes.
30. Lungs.
31. Heart:
   a. Left auricle.
   b. Left ventricle.
   c. Right auricle.

31. Heart—*Continued*.
   d. Right ventricle.
   e Left auriculo-ventricular or mitral valve.
   f. Right auriculo-ventricular or tricuspid valve.
   g, *g*. Cordæ tendinæ or tendinous cords.
32. Aorta.
33. Posterior aorta.
34. Anterior aorta.
35. Pulmonary artery.
36. Posterior vena cava.
37. Cervical vertebræ.
38. Dorsal vertebræ.
39, 39. Lumbar vertebræ.
40. Sacrum.
41, 41. Coccygeal vertebræ
42, 42. Ligamentum nuchæ.
43. Septum nasi.
44. True ribs.
45. False ribs.
46. Intercostal muscles.
47. Sternum or breast bone.
48. Floor of pelvis.

I.



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